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CONTENTS

(Continued on Next Page)

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: (1) progress reports on long-term major research projects; (2) final reports on short-term projects and (3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

CONTENTS

(Continued from Outside Front Cover)

LABOR EFFICIENCY AND DAIRY COSTS

By E. H. CARTER
SECTION OF FARM MANAGEMENT

HIGH LABOR efficiency reduces costs. Labor requirements varied from 71 hours for the lowest to 347 hours per cow for the highest of 105 dairy farms in a cooperative dairy cost study between the Farm Management Section of Michigan State College and the Michigan Milk Producers' Association. Thus there was a difference of 276 hours per cow between the most and the least efficient dairymen from the standpoint of labor requirements. At an average cost of 74 cents per hour this would amount to over $200 labor cost per cow more for one dairyman than another.

Twenty dairymen spending the least time averaged 89 hours per cow and had labor costs of $70 per cow, whereas 20 dairymen spending the most time averaged 184 hours per cow and had labor costs of $126 per cow (Table 1). With the 20 low-hour farms, labor comprised 25 percent of all costs, but on the 20 high-hour farms, labor amounted to 38 percent of all costs. When figured on a per 100 pounds of milk basis, labor costs amounted to $1.53 for the 20 high-hour farms, but only 88 cents for the 20 low-hour farms, a difference of 65 cents a cwt. in cost of production.

TABLE 1—*Relation of labor hours per cow to costs and returns, 1945-46*

Item	Hours labor per cow				
	71-100	101-113	114-138	139-158	159-347
Number of herds	20	20	25	20	20
Cows per herd	18	17	17	18	15
Labor hours per cow	89	108	126	148	184
Butterfat production per cow (lb.)	284	285	308	305	301
Milk production per cow (lb.)[1]	7,900	7,800	8,000	8,300	8,200
COSTS PER COW					
Labor	$ 70	$ 90	$ 92	$ 105	$ 126
Total	270	292	313	320	335
Labor cost per cwt. of milk	$ 0 88	$ 1.15	$ 1.15	$ 1.26	$ 1.53
RETURN PER HOUR LABOR	1.14	93	.80	.74	.63
NET RETURN PER COW	31.72	9.98	7.82	4 12	−10.25

[1]Milk production per cow figures rounded to nearest 100 pounds.

ARTICLE 30-1

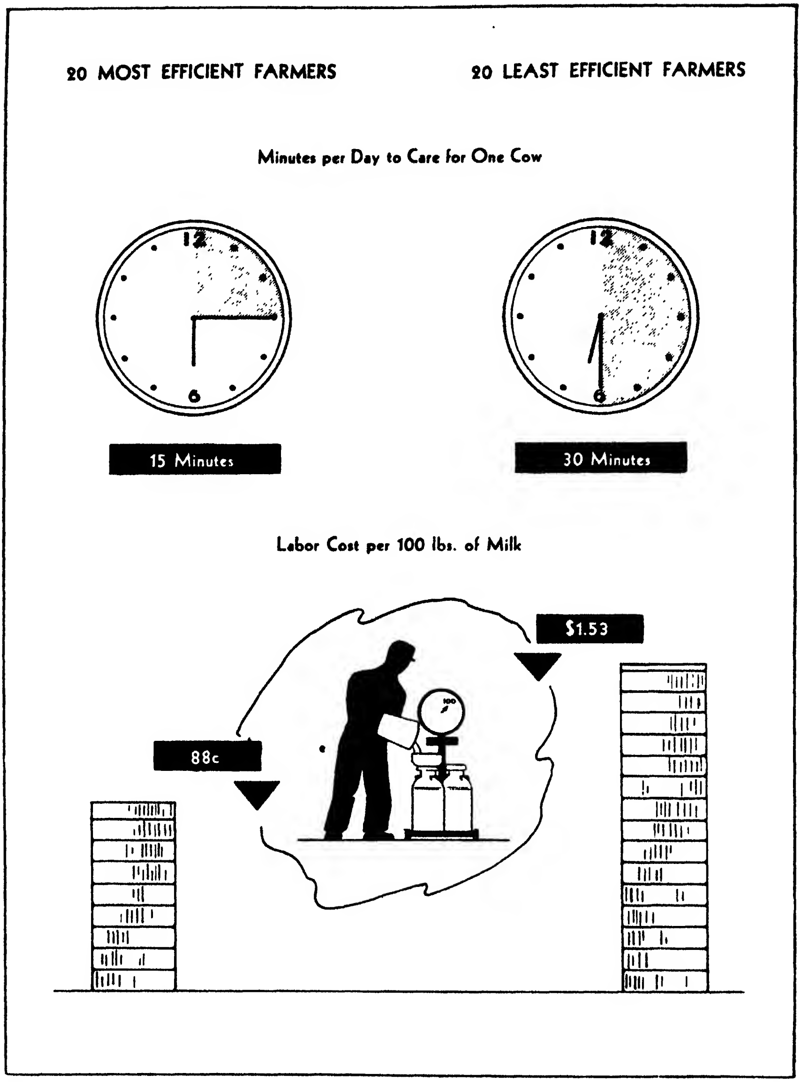

Fig. 1. Comparison of the 20 most efficient with the 20 least efficient dairymen with respect to labor requirements and labor cost of 100 pounds of milk.

Net returns per cow were lower for dairymen who required more hours to care for their herds. The 20 low-hour dairymen received $31.72 per cow above all costs, but the 20 high-hour dairymen lacked

$10.25 of paying costs. Stated another way, the same 20 low-hour farmers received $1.14 per hour for labor, whereas the 20 high-hour farmers received only 63 cents.

Higher labor requirement was not closely associated with higher production per cow. The hours per cow for the high-labor group was little over twice that of the low-labor group, but butterfat production was only about 6 percent higher. The low-hour farmers had herds averaging one-fifth larger than the high-hour farmers.

The 10 most efficient dairymen and the 10 least efficient dairymen, from the standpoint of labor hours per cow, were selected from Table 1 for further study (Table 2). The use of labor-saving equipment and the convenient location of the milkhouse to the barn were factors associated with low-labor requirement. "Fast" milking was practiced by twice as many dairymen of the 10 low-labor group as in the high-labor group. Grain parts were used by four times as many dairymen in the low-labor group as in the high-labor group.

The average distance between cow barn and milkhouse was about a third less on the 10 low-labor farms. As to the methods of handling the manure, more farmers in the low-hour group used litter carriers and fewer farmers forked by hand than farmers in the high-hour group. The age of the farmer tended to be lower for the more efficient group than for the less efficient group. The degree of chore planning also was a contributing factor to lower labor requirements.

This analysis shows that practices and methods used by some dairymen can cut chore time by more than half. Labor costs can be reduced as much as 65 cents per cwt. and returns can be increased by as much as 50 cents per hour.

TABLE 2 -- *Comparison of labor practices on high- and low-labor hour farms. 1945-46*

Item	Labor hours per cow	
	Low 10 herds	High 10 herds
Cows per herd	17	13
Labor hours per cow	83	209
LABOR PRACTICES		
Percent of operators practicing "fast" milking	60	30
Percent of operators using grain cart	40	10
Percent of operators using silage cart	38[1]	29[2]
Distance from barn to milkhouse (ft.)	72	111
Manure handling		
Percent operators using litter carrier	40	10
Percent operators using wheelbarrow	40	50
Percent operators forked from barn by hand	20	40

[1]Two of low 10 herds fed no silage.
[2]Three of high 10 herds fed no silage.

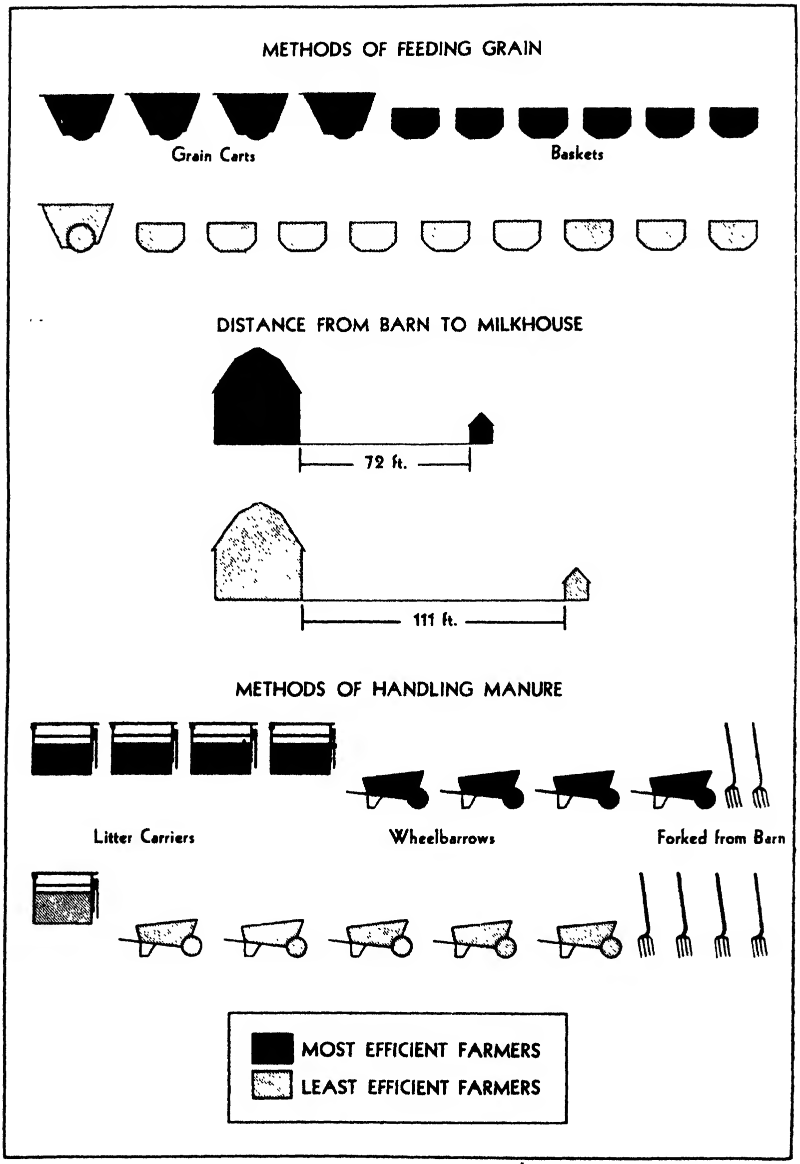

Fig. 2. Comparison of the 10 most efficient with the 10 least efficient dairymen with respect to labor practices, equipment, and distance from barn to milkhouse.

TESTS WITH DEPTHS OF PLOWING

By C. E. MILLAR and A. G. WEIDEMANN
SECTION OF SOIL SCIENCE

THE PRACTICE of soil tillage is perhaps as old as civilization. McConnell (5), according to Sewell (11), ascribes the origin of tillage to the wild boar and the observations of ancient races that plants flourished in ground previously rooted by this animal. Sewell (11) also states that "Sculpturing 4,000 years old depicts a wooden plow drawn by animals." Since those days the plow has developed into a very scientifically designed implement. Incidentally, in the minds of some people, it now faces extinction. In general, however, it is looked upon as an implement that is here to stay for some time yet, despite the fact that new methods of tilling the soil are continually appearing. A considerable amount of research has been done to determine how deep soil should be plowed and what other practices should be used in conjunction with plowing for tilling the subsoil. Some have held that deep tillage is necessary to provide greater space for root development. But Weaver (13) and many others have shown that under favorable conditions the roots of corn, small grain and some other field crops penetrate to depths of more than 7 feet. Alfalfa roots have been reported to have gone down as far as 35 feet. All this is accomplished without any artificial preparation of the subsoil. Among factors influencing root penetration, natural habit of the plant, the depth to the water table and permeability of the subsoil should be mentioned.

REVIEW OF LITERATURE

Only a few of the many reports of investigations dealing with the effects of deep tillage on crop production can be mentioned here. Cardon (1), in 1915, reported that the results of five years' work with winter wheat at Nephi, Utah, showed no advantage of deep plowing or subsoiling over shallow plowing so far as moisture conservation was concerned, and there was also no material differences in the yields. Highest average yields were from 10-inch plowing, and 5-inch plowing

yielded higher than subsoiling either 15 inches or 18 inches deep. Plowing and subsoiling was just about twice as expensive as plowing only. At the Pennsylvania station experiments were conducted for 3 years on Hagerstown soil (chiefly clay loam) to test the effect of depth of plowing on draft requirements and crop yields. Plowing was done in both spring and fall, with the moldboard plow to a depth of 7.5 inches and with the Spalding deep tillage machine to depths as great as 15 inches. Soil was plowed for corn, oats, barley, wheat and alfalfa. Noll (8) reports that under the conditions the two kinds of plowing gave practically the same results with all crops grown. The average draft required for the Spalding plow was about 2.65 times as great as for the ordinary plow. Mosier and Gustafson (6), reporting on subsoil tillage experiments conducted on corn in Illinois for a period of 8 years on gray silt loam on tight clay, state that with every soil treatment there was an almost uniform decrease in yield for subsoiling. The subsoil plow was run in the bottom of the furrow made by the ordinary plow, loosening the subsoil but not turning it up. The general average for 8 years showed a decrease of 2.7 bushels of corn per acre for subsoiling. Ricks (9) of Mississippi says: "Subsoiling for corn, as well as for any other crops, gives us no returns. On land where there is a hardpan it is advisable to subsoil." Plowing with an ordinary plow in 1913 and 1914 gave better yields of corn than subsoiling either with subsoil plow or dynamite. The same author (10) found that good deep plowing (7 inches deep) was as satisfactory for alfalfa as subsoiling with dynamite or with a subsoil plow to a depth of 18 inches. Chilcott and Cole (2) carried on subsoiling experiments at 12 stations in nine of the Great Plains states using several of the common farm crops. They found that the practice increased some crop yields in some seasons. On the average, subsoiling, instead of overcoming the effects of drouth, actually intensified them. They drew the following conclusions: "Recognizing the fact that there may be times and places giving results favorable to subsoiling or other methods of deep tilling, the average yields obtained in the experiments here reported seem to warrant the conclusion that as a general practice for the Great Plains as a whole no increase in yields or amelioration of conditions can be expected from the practice." At the Ohio station experiments were carried on involving 7.5-inch plowing, 15-inch plowing and 7.5-inch plowing followed by subsoiling to a depth of 15 inches. The treatments were made for corn and wheat in a rotation of corn, oats, wheat and clover. Director Williams (14) drew the following

conclusions: "It would be difficult to arrange a uniform treatment which would result in yields more nearly identical. In view of the expense involved it is evident that the 7.5-inch plowing is by far the most profitable."

In contrast to the results given in the foregoing reports there are reports of benefits from deeper tillage. Lyon (4), in Nebraska, questioned farmers concerning their opinion as to the value of deep tilling for corn. On clay subsoil 80 percent favored subsoiling. On loam subsoil only 23 percent favored subsoiling. Subsoiling reduced yields on porous subsoil. Shaw (12), of California, reports substantial increases in yields of small grain in California from deep plowing. As an average of 40 trials on depth of plowing he gives the following yields of wheat and barley at Davis, California.

TABLE 1—*Yields of wheat and barley as affected by depth of plowing*

Treatment	Bu. wheat	Bu. barley
Deep plowing	29.78	75.98
Shallow plowing	21.67	69.30

The actual depth of plowing in this case was not stated but elsewhere in the article it was stated that the usual depth of plowing for small grain in California was 3 to 4 inches. Also it was stated that plowing for wheat should be at least 8 inches and under some conditions 12 inches deep. Lipman (3), also of California, says deep plowing is the first requisite to successful agriculture in California from the standpoint of soil management. He attributes that to the fact that much of the soil of California is deep and is the same at depths of 2 or 3 feet as at the surface. He intimates that root development is governed by depth of tillage and sees no reason why the fertility of the soil should not be utilized to depths of a foot or more instead of confining the roots of plants to a thin layer of soil. Nissley (7), of the New Jersey station, found that deep plowing, turning up about 2 inches of yellow subsoil, and apparently breaking up a hardpan, meant the difference between a good crop of spinach and an almost total failure in that state. A pan-breaking attachment on the plow has provided similar results on other fields growing vegetables in New Jersey. He has written rather extensively on the subject, and his general conclusions are that many, but not all, New Jersey soils

are benefited by the treatment. His reports add further support to the general belief that some soils under certain conditions are benefited by deep tillage while others are not.

EXPERIMENTAL

In 1931 an experiment was started on Hillsdale sandy loam soil on the Michigan State College farm at East Lansing to test and demonstrate the effect of different depths of plowing on the yield of crops. Corn, barley, clover and wheat were grown in rotation in the order mentioned. Rye was seeded after wheat to be plowed down as green manure for corn. The soil was plowed at depths of 4, 7, and 10 inches for corn and wheat, and disked for barley and for rye green manure. Plowing was done with a two-way 14-inch bottom plow, and aside from the depths of plowing the cultural practices for all plots were practically the same. Fertilization of all plots was also the same, 300 pounds of 2-12-6 being drilled with wheat and with barley. During the progress of the experiment, which has covered a period of 14 years, clover failed three times because of drouth. There were no clover harvests for those years but the plots were seeded back to clover each time to provide a clover sod to be plowed down for wheat. In the spring of 1946 dynamometer tests were made to determine the comparative drafts required for different depths of plowing. The results of the dynamometer tests are given in Table 3 while the crop yields are shown in Table 2.

DISCUSSION

From the viewpoint of 14-year averages, the highest yields of clover hay, corn grain and corn stover were secured from 4-inch plowing, the next highest from 7-inch plowing and the lowest from 10-inch plowing. For wheat and barley, both grain and straw, the reverse is true. Some of the differences are very small, while others seem to be very significant, especially in the cases of corn and barley. In general, significantly larger corn yields were obtained on the shallow plowed soil in the more favorable corn years such as 1935, 1937, 1938, 1940, 1942, and 1943. The seasons of 1934, 1936, 1939, 1944, and 1946 were too dry for corn, and 1945 was far too wet.

The annual yields of wheat and clover are rather variable for the different depths of plowing, but the variations in the 14-year averages,

(bushels of grain and pounds of stover, straw and hay)

Depth of plowing	Product	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	14-year average
									Corn							
4 inches	Grain	35.7	16.8	55.0	22.7	49.9	62.7	22.6	45.6	34.3	65.7	58.9	14.6	61.3	16.4	40.1
	Stover	3371	2830	2036	2719	2830	4235	2445	2779	2411	2720	4042	3230	6649	3183	3313
10 inches	Grain	33.9	22.5	43.3	21.9	44.4	59.6	22.6	33.7	25.5	51.6	29.9	13.4	45.0	17.6	32.1
	Stover	2828	2142	2436	2663	2046	3362	2258	2042	2573	3917	2265	2567	5806	2554	2853
7 inches	Grain	36.7	19.7	45.0	21.8	44.1	56.8	25.0	44.1	28.0	58.2	34.8	13.1	35.5	18.7	34.4
	Stover	2950	2463	2453	2682	2777	4092	2283	2757	2551	4970	3208	3021	5495	2751	3111
									Barley							
4 inches	Grain	8.1	13.8	33.5	24.6	22.4	27.0	20.2	32.1	23.9	24.2	9.7	23.0	22.4	29.1	23.1
	Straw	622	919	1472	1043	948	1216	1517	1220	1394	1235	1050	1355	981	1379	1166
10 inches	Grain	11.7	11.5	39.6	26.3	29.4	28.4	32.0	33.9	29.8	25.7	20.4	31.0	37.4	31.4	28.0
	Straw	862	790	1708	1173	1285	1197	1598	1432	1441	1350	1431	1513	1493	1436	1336
7 inches	Grain	9.5	12.6	36.8	24.8	22.2	29.6	30.1	36.7	23.7	23.1	10.2	24.2	22.8	34.4	24.6
	Straw	740	790	1441	1046	905	1235	1685	1413	1302	1359	1245	1340	938	1556	1213
									Clover							
4 inches	Hay	3581	596	*	3720		3539	1983		4113	3142	3366	3033	2829	3209	2360
10 inches	Hay	2053	347		3733		3816	1842		4350	2776	3088	2517	2235	2798	2109
7 inches	Hay	3929	642		3630		3425	2212		3859	3033	3311	2313	1845	2895	2237
									Wheat							
4 inches	Grain	30.6	26.9	25.6	29.9	33.0	30.9	34.8	33.9	26.9	37.9	22.4	37.9	48.2	41.7	33.1
	Straw	2963	2003	2598	2130	4325	2408	2556	2819	2498	3183	2197	3710	5438	3498	3003
10 inches	Grain	28.4	26.9	24.5	31.0	38.3	39.7	36.1	37.1	35.5	42.4	27.8	40.1	54.5	42.6	36.1
	Straw	2666	2391	2238	2188	4739	3183	2766	3040	3111	3772	2781	3815	5903	3427	3206
7 inches	Grain	30.7	27.5	27.8	30.2	37.7	34.3	37.6	41.8	33.4	38.0	25.9	42.7	51.7	44.2	36.0
	Straw	2762	2085	2640	2135	4461	2642	2891	3379	2810	3131	2274	4141	5706	3379	3174

*Clover failed three times because of drouth. The average yields are the total yields for 11 harvests divided by 14. When clover failed it was reseeded to be plowed under, but no harvest was secured.

although in a definite order, favoring deep plowing in the case of wheat and shallow plowing in the case of clover, as already mentioned, are not very great. Although the subsoil was not very heavy, as the experiment progressed and the subsoil became more thoroughly mixed with the surface soil on the 10-inch plowed plots, it was observed that there was a growing tendency for the soil to crust over upon drying after a rain. No effect of this crusting was observed in connection with wheat and barley but it tended to interfere with the emergence of corn plants, thus affecting the stand in some instances.

For a number of years the plowing was done with two large horses and it was found necessary to let them rest at least half of the time while doing the 10-inch plowing. Although the tractor used in later years handled the plow without much difficulty it was evident that considerably more power was required for the 10-inch plowing than for the other two depths. Dynamometer tests made in the spring of 1946, the results of which are recorded in Table 3, reveal that the 10-inch plowing required more than twice as much draft as the 4-inch plowing and about 50 percent more than the 7-inch plowing. While the 4-inch plowing was very economical on draft requirement, great care, low speed and a narrow furrow were necessary requirements for properly turning such a thin furrow slice.

Table 4 gives the value of the crops from different depths of plowing, based on 1946 average prices paid to farmers. These figures reveal a difference of less than $2 in the value of the 14-year average crop yields per rotation from the three different depths of plowing. The value of crops from 7-inch plowing is $1.94 less than that from the 4-inch plowing, and only 35c less than that from the 10-inch plowing. These differences seem to be definitely insignificant.

TABLE 3—*Effect of depth of plowing on draft requirement in pounds**

Trials	Draft requirements for different depths		
	4 inches	7 inches	10 inches
1	370	530	760
2	370	550	850
3	380	500	—
4	380	560	—
Average	375	535	805

*The writers are endebted to E. C. Sauve of the Agricultural Engineering Department of Michigan State College for his cooperation in making the draft requirement tests.

TABLE 4—*Value of 14-year average yields of crops per rotation from different depths of plowing*

(Based on 1946 average prices paid to farmers)*

Depth of plowing		4 inches		10 inches		7 inches	
Crop		Yield**	Value	Yield	Value	Yield	Value
Corn	Bu. grain	40.1	$ 58.55	32.1	$ 46.87	34.4	$ 50.22
	Lb. stover	3313	8.28	2883	7.21	3111	7.78
Barley	Bu. grain	23.1	31.42	28.0	38.08	24.6	33.46
	Lb. straw	1166	2.92	1336	3.34	1213	3.03
Clover	Lb. hay	2360	20.01	2109	17.91	2237	18.99
Wheat	Bu. grain	33.1	61.24	36.1	66.79	36.0	66.60
	Lb. straw	3003	7.51	3266	8.17	3174	7.94
	Total		$189.96	--	$188.37	--	$188.02

*Grain and hay prices taken from the report of the government agricultural statistician's office, Lansing, Michigan. Straw and stover prices estimated. Corn $1.46; barley $1.36; and wheat $1.85 per bu. Straw and stover $5.00 per ton; and hay $16.98 per ton.
**14-year average yields taken from Table 2.

CONCLUSIONS

The inconvenience associated with 4-inch plowing, and the great amount of draft required for 10-inch plowing coupled with the comparatively small yield increases for these two depths of plowing suggest that for this type of soil and the crops grown plowing to the usual depth of 7 inches is still the most economical practice.

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HEATING WITH SAWDUST

By MAURICE W. DAY
DUNBAR FOREST EXPERIMENT STATION

IN 1946 the sawmills of Michigan produced 670,500,000 board feet of lumber, 30 percent of which was softwood. About 60 percent of the total production was manufactured by mills cutting less than 5 million feet annually. A large proportion of these smaller mills use Diesel or gasoline engines for power and therefore cannot burn their sawdust for the production of power. In most cases the sawdust is wasted, and there may even be some expense in disposing of it. Despite this waste of approximately the equivalent of 5 million cubic feet of wood annually in Michigan alone, little progress has been made in finding a use for sawdust.

Sawdust is used for heating in parts of Oregon and Washington, but generally it is not utilized for this purpose in Michigan. So a trial of sawdust as a fuel for home heating was made at the Dunbar Forest Experiment Station during the winter of 1945-46.

A commercial sawdust burner manufactured in Portland, Oregon, and costing approximately $50 f. o. b. Portland, was secured for the trial. This burner was designed for attachment to a regular coal or wood burning hot air furnace; sawdust burning hot water heaters are also available. The burner consisted of a fuel hopper, grates and combustion chamber.

No difficulty was experienced in installing the burner and putting it in operation according to the manufacturer's instructions. The building heated was a frame 28′ x 34′ uninsulated bungalow containing approximately 7,000 cubic feet of air space. The chimney in this house has a large flue so that a good draft is obtained.

The sawdust burner operated satisfactorily and produced a uniform heat which could be more evenly controlled than a wood fire. Despite minimum outside temperatures of –29 degrees F. no difficulty was experienced in obtaining sufficient heat. A total of 150 cubic yards of sawdust was used during the heating season, from September

ARTICLE 30-3

through June. Except during the coldest weather it was not necessary to replenish the fuel hopper more than 3 or 4 times in 24 hours.

Although the burner was designed for conifer sawdust, a mixture of hardwood and conifer sawdust burned satisfactorily in it. No trial of all hardwood sawdust was made, but the U. S. Forest Products Laboratory in Madison, Wisconsin, has successfully used fresh oak sawdust in a similar burner.

Sawdust used for heating purposes should be placed in dry storage and not allowed to remain outside in piles exposed to the rain and snow. This, of course, involves considerable storage space unless sawdust can be obtained as required from an operating mill. Obviously, too, the economy of using sawdust is affected by the distance to the mill, or mills, from which a steady and adequate supply may be obtained.

From this preliminary test it would seem that the use of sawdust burners for heating has possibilities in Michigan wherever a supply of sawdust is available and proper arrangements can be made to handle and store it.

REDUCING CHORE LABOR ON DAIRY FARMS

By B. R. BOOKHOUT
FARM MANAGEMENT DEPARTMENT

CHORE WORK makes up more than half of the total yearly work on dairy farms. The return that a farmer gets for his labor depends to a considerable extent on the effectiveness of his daily work. What are the important chore jobs? What are the differences in labor requirements on different farms? What are the causes of these differences? How can the job be improved to give more effective use of labor? To answer these and other questions, a detailed study of chore work on dairy farms was started in the spring of 1946.

TOTAL CHORES

The chore time on 10 selected dairy farms during the winter season averaged about 6 hours a day, see Table 1. Work with dairy cows made up 86 percent of the total chore work. The other 14 percent was distributed as follows: 5 percent to young stock and bull, 4 percent to poultry, 2 percent to hogs, 1 percent to horses, and 2 percent to miscellaneous chore work.

DAIRY CHORES

To study further the daily chore work, the time spent with dairy cows was broken down into the following jobs: getting cows in and

TABLE 1—*Distribution of winter chore time on 10 central Michigan farms,*[1] *1946*

Enterprise	Average time per day	Percent of total
Dairy cows	5 hrs. 9 min.	86
Young stock and bull	18 min.	5
Poultry	13 min.	4
Hogs	8 min.	2
Horses	4 min.	1
Miscellaneous	7 min.	2
Total	5 hrs 59 min.	100

[1] Average numbers of livestock on these farms were as follows: Cows *18*, young stock and bull *11* hens *140*, sows *2*, and horses *0.7*.

ARTICLE 30-4

TABLE 2—*Distribution of chore work with dairy cows on 10 central Michigan farms, 1946*

Job	Average time per day	Percent of total
Milking	2 hrs. 27 min.	48
Cleaning mangers and feeding cows	48 min.	16
Caring for utensils	42 min.	13
Cleaning stables and bedding cows	40 min.	13
Caring for milk	18 min	6
Getting cows in and out of barn	13 min.	4
Total	5 hrs 8 min.	100

out of barn; cleaning mangers and feeding the cows; milking; caring for milk; caring for utensils; and cleaning stables and bedding the cows. The average daily time requirements for each of these jobs is shown in Table 2. The jobs are ranked from high to low according to the time taken.

MILKING TAKES THE MOST TIME

The fact that milking comprised 48 percent of the time spent with dairy cows indicates the importance of reducing the time on this job. The three possible approaches to the problem of reducing the milking time are as follows: (1) Improving stable layout; (2) improving the equipment; and (3) improving the work methods.

An individual farmer usually makes use of a stable "as is" because of the expense of changing to a more convenient layout. On many farms, however, there is a great chance of improving the stable by minor changes such as moving a door, relocating an alley or changing a hay chute. It is interesting to note that more than 60 percent of the dairy work takes place behind the dairy cow while only about 15 percent takes place in front of the cow. Thus in planning a new or in remodeling an old stable, the relative importance of the location of the work should be considered before deciding on the stable arrangement. Some dairymen have adopted the pen-type barn when building new or remodeling old barns. This type of barn has both advantages and disadvantages which should be investigated before constructing the barn. Some farmers have been successful in the use of the pen-type barn while others have not. It should be pointed out that the pen-type barn affects the jobs of feeding the cows and cleaning out the manure more than the jobs associated with milking.

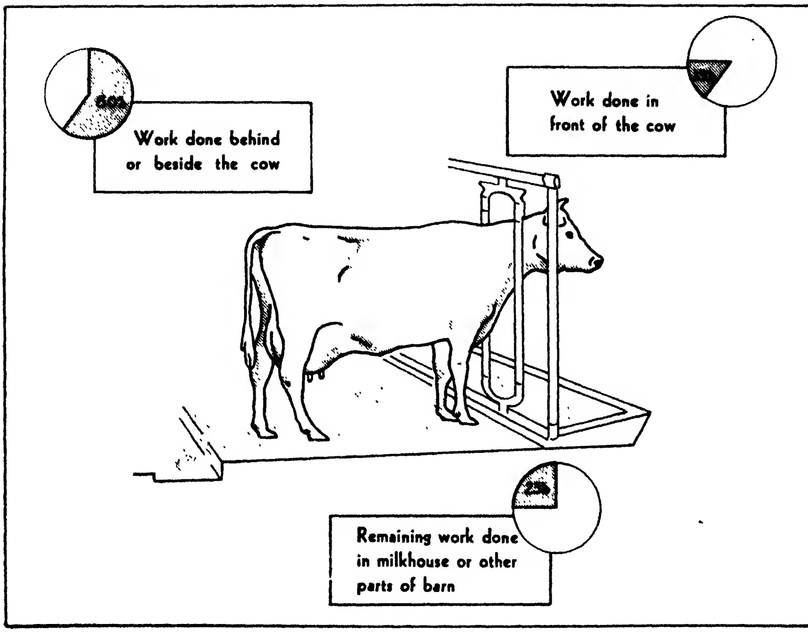


Fig. 1. Location of chore with dairy cows.

The second means of reducing the milking labor is to use more efficient equipment. The farms included in this study had standard commercial milking machines. Further improvement in milking machines and in carts for moving milk and utensils will reduce the milking time.

The third and perhaps the most important means of reducing milking time is improvement of the methods of doing the work. To aid in the study of time reduction, the job of milking was broken down into eight operations. The average time for each of these operations on the 10 farms is shown in Table 3.

The total milking time per cow per day on these ten farms ranged from about 7 minutes to 22 minutes. This was a range of from 56 percent of the average to 165 percent of the average of the 10 farms. Without any reference to the figures on the individual records, several important ideas can be pointed out from a study of this table.

1. **Machine Milking**—The time spent in milking with the machine was generally the most important part of the job of milking. This

TABLE 3—*Average time spent on milking operations per cow per day on 10 central Michigan farms, 1946*

Milking operation	Farm number										
	2	13	8	10	3	7	5	9	4	6	Average
Number of cows milked	16	25	10	12	36	13	8	15	19	9	16.3
Number of men	1	1	1	1	2	2	1	2	2	2	—
Number of milker units	2	2	2	2	3	2	2	2	2	2	—
	Minutes per cow per day										
Preparing milking equipment	0.5	0.6	0.6	1.1	0.6	0.3	0.5	1.2	0.6	1.0	0.7
Milking with machine	5.2	5.8	5.9	4.7	2.9	4.3	8.1	7.3	7.6	5.7	5.8
Waiting while milking	—	.2	.4	.5	.1	3.5	3.8	3.1	1.8	3.6	1.7
Hand stripping	.4	..	—	.2	5.5	—	.1	3.1	2.7	.2	1.2
Hand milking	..	—	—	1.4	.2	—	.	—	—	5.5	.7
Caring for milk	.1	.3	.9	.3	.8	4.0	.7	.3	2.8	1.0	1.1
Caring for utensils	1.3	1.3	1.9	1.5	1.2	2.4	2.7	1.6	2.8	5.2	2.2
Total time	7.5	8.2	9.7	9.7	11.3	14.5	15.9	16.6	18.3	22.2	13.4

time ranged from about 3 to 8 minutes per cow per day. The variation was due partly to the difference in rate of movement of the machine operator and partly to the organization of the work. The better operators kept the units together, milked the cows in order, and had the work organized so that there was a minimum of waste motion.

2. **Hand Milking and Stripping**—The lowest time requirements were on farms where hand milking and stripping had been eliminated. On three of the farms, one or two cows were usually milked by hand even though most of the herd was milked with the machine. On one farm the time spent in hand stripping was nearly twice as great as the time spent in handling the machine.

3. **Caring for Utensils**—The time spent in preparing the utensils before milking and in caring for them after milking varied considerably. There is no clear-cut relationship, but the lower records of time spent on these operations were on farms where the milkhouse was near the barn and was well equipped for washing and storing the equipment.

4. **Caring for the Milk**—The variation in time for caring for the milk was caused chiefly by the location of the milkhouse and by the type of cooler used. A milkhouse near the barn reduced the time

in carrying the milk from the barn. An electric cooler or a tank cooled with water took a minimum of the operator's time because the cans were merely put in the cooler and no further attention was needed. Some form of agitator or spray aerator cooler took more of the operator's time because the cooler had to be changed from can to can during the cooling process.

5. **Idle Time**—The time spent waiting for the machine to complete the milking varied from zero to 3.77 minutes per cow per day. The amount of waiting can be taken as an indication of the organization of the work and the operation of the milking unit. On the farms with the low-total milking times the work was organized so that there was very little waiting.

MACHINE TIME PER COW

Another way of showing the differences in the work methods between farms is to follow the machine instead of the operator. The average time that the machine was on a cow for each milking is shown in Table 4.

The time the machine was on the cow was recorded from the time all the teat cups were in place until all the teat cups were removed. Any time spent in "machine stripping" was included in the time the machine was on the cows.

The average machine time per cow ranged from a low of 4.8 minutes to a high of 11.5 minutes. In other words, the farmer with the low average time per cow would be able to milk more than two cows, while the farmer with the high average time per cow

TABLE 4—*Average time milking machine was on each cow on 10 central Michigan farms, 1946*

Farm number	Cows milked	Average machine time per cow	Range in machine time per cow	
			Low	High
		minutes	*minutes*	*minutes*
13	25	4.8	3.1	9.1
2	16	4.9	3.6	8.7
3	36	4.9	1.9	9.9
8	10	5.0	3.4	9.6
10	12	5.7	3.2	12.3
4	19	5.8	3.7	10.4
9	15	5.9	2.1	11.8
7	13	6.2	3.0	12.4
6	9	7.5	5.4	12.9
5	8	11.5	7.8	19.5

was milking one cow. This indicates that there is a great opportunity to reduce the time spent in milking by training the cows to milk rapidly. Experimental evidence has shown that with the proper technique cows can be milked with about 3 minutes of machine time per cow. If the farmers in this study could reduce their machine time to that level, the milking time would be one-third less on the farm with the low record. On the farm with the high record the milking time would be only a little over one-fourth of the present time if the goal of 3-minute milking were reached.

RECOMMENDATIONS FOR REDUCING CHORE LABOR

From the information presented in this article and from other studies of chore records the following recommendations are presented for the purpose of reducing chore labor.

1. Arrange buildings for convenience
   a. Change building layout to reduce the work to be done
   b. Locate feed storage and chutes for convenience
   c. Locate doors, gates, and electric switches where they are needed
   d. Locate the milkhouse as near stable as possible

2. Make more effective use of equipment
   a. Keep equipment in good repair
   b. Store tools in handy places
   c. Substitute equipment for hand work where possible
   d. Use carts for transporting heavy loads

3. Improve work methods
   a. Practice "managed" or "3-minute" milking
   b. Milk cows in order and keep milker units together
   c. Eliminate all unnecessary operations
   d. Eliminate back-tracking and waste motion

PROTECTION OF CROPS FROM FROST DAMAGE BY USE OF RADIANT ENERGY– PART II

By F. HASSLER[1], *C. L. HANSEN*[2] *and A. W. FARRALL*[3]
SECTION OF AGRICULTURAL ENGINEERING

A PRELIMINARY REPORT of the use of infrared radiant energy for protection of crops from frost damage, was made in the *Quarterly Bulletin* for November 1946 (pp. 53-63). Since that time, further information has been obtained which it is believed will be of interest and value to agriculture.

It was apparent from data previously reported that effective frost protection could be secured by use of infrared radiant energy on low-growing crops if a certain level of energy application were made.

Problems remaining to be solved consisted principally of: (1) Determination of improved methods of generating large quantities of infrared energy at low cost; (2) determination of most efficient methods of distributing radiant energy at the intensities needed; (3) determination of effectiveness of radiant energy in protecting large trees from frost damage.

GENERATION OF INFRARED ENERGY

Investigation showed that it was possible to generate infrared energy quite efficiently through the use of a generating type of oil burner, using kerosene or No. 1 fuel oil as a source of heat and enclosing this flame in a properly baffled sheet iron stove. Uniformity of heating is an important item in the operation of apparatus of this type.

Tests of one type of unit gave the following performance:

Stack temperature	1100° F.
% energy up stack	27.3
% energy carried off by convection	36.8
% energy radiated	46.5

[1]Instructor in Agricultural Engineering.
[2]Assistant Professor of Agricultural Engineering.
[3]Professor and Head of Agricultural Engineering.

ARTICLE 30-5

Fig. 1. Illustration showing diaphragm-type fuel oil pump which operates from 6-volt battery and supplies oil to burner at pre-determined pressure.

This indicates that there is still much room for improvement in the efficiency of these radiating units.

An important part of the development of the generator unit was that of a light-weight, inexpensive fuel supply system.

Fig. 1 shows one type which was found to be quite satisfactory. This unit consists of a small-diaphragm-type fuel pump driven by a 1/20 H.P. 6-volt D.C. motor. The unit will draw fuel oil out of a fuel oil barrel by suction and supply it at a steady pre-determined pressure to the burner. The automatic pressure control is obtained by adjustment of the tension of a spring on the connecting rod of the pump. The pump will operate more than 20 hours off one charge of a 120-ampere hour, 6-volt auto-type storage battery and will supply fuel for a burner of 1½ million BTU per hour. This pump and burner may have important uses wherever light weight portable oil burners are needed, in industry or agriculture.

DETERMINATION OF METHODS OF DISTRIBUTING RADIANT ENERGY

The problem of building an efficient large-size radiator for infrared energy is made difficult because the intensity of energy from a point source decreases as the square of the distance, thus unless compensated for in some manner, the intensity at 100 feet from the source would be only 1/100 as great as at 10 feet. Further difficulty

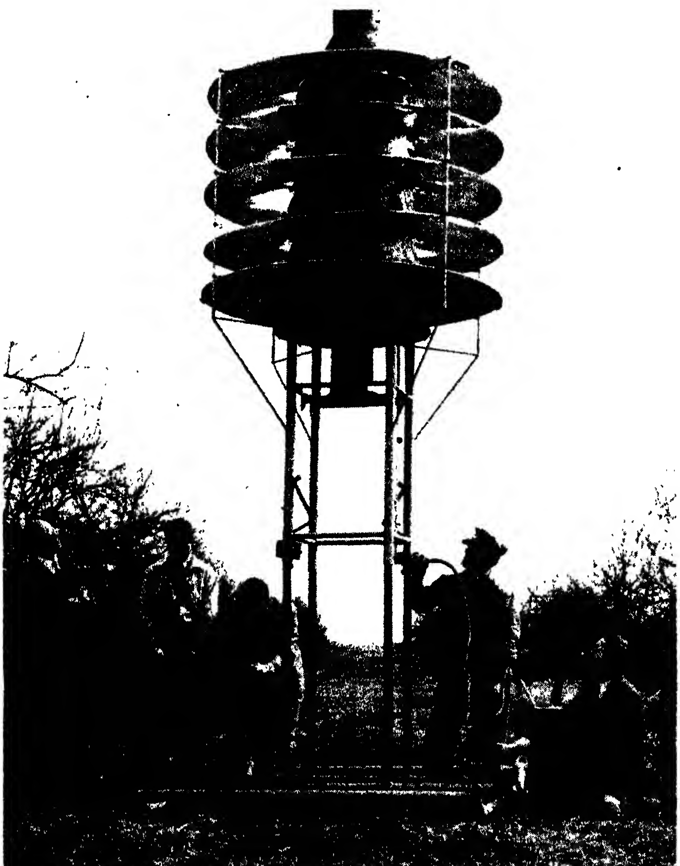


Fig. 2. Type "B" frost prevention unit which was one of the heaters used in orchard tests. Note fuel pump arrangement and instruments.

arises, owing to the fact that radiant energy is given off from a point source in all directions and the distribution of energy from a flat surface generator follows the cosine law. This means that not only is the greatest intensity at 90° from the surface of the radiating surface but that also large quantities of energy are also given off at an angle, thus making it difficult to focus energy from a large surface. Several different shapes of generators and reflector combinations were studied and tested with laboratory apparatus, using an Eppley Radiation Meter to measure radiation intensity and distribution. From the data thus obtained, three different full-scale models of frost prevention units were built.

Fig. 2 shows a photo of type "B" unit which gave the most uniform distribution of radiant energy. It will be noted that with this unit, a large percent of the radiant energy is caught on the reflectors and focused as effectively as possible at a distance of approximately 80 feet from the unit. Scattering of rays causes them to cover an area of more than an acre.

Fig. 3 is a chart showing the intensity of radiation at various distances from the unit, together with fuel consumption and other operating data. It will be noted that the intensity is much greater near the unit than at a distance. However, the distribution was such that there was a noticeably greater intensity at the edge of an acre plot as compared to other types of heaters and as compared to when reflectors were not used. The intensity near to the unit is not sufficiently great as to cause damage to plants on the ground.

DETERMINATION OF EFFECTIVENESS IN PROTECTING CROPS AGAINST FROST DAMAGE

During the spring of 1947, at East Lansing, there was no frost at the time fruit blossoms were out and a direct test could, therefore, not be made; however, a series of tests were made under frost conditions previous to blossoming.

Three test units were set up in the College apple orchard and observations made both on individual machines and with a combination of the three operating at the same time. Fig. 4 shows the arrangement of the units in the orchard, indicating how they were

TEST DATA FOR FROST PREVENTION UNITS

DATE 4-21-47 TAKEN BY FARRALL, HANSEN, HASSLER, PORTER

PLACE ACROSS ROAD SOUTH OF CHEMISTRY BLDG.

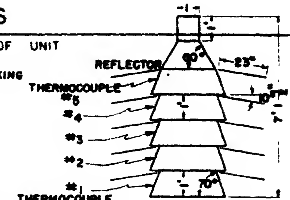
TYPE OF UNIT TYPE "B" TYPE OF BURNER MODIFIED AEROIL

MODIFICATION OF UNIT 1" DIST. BETWEEN BAFFLE & INSIDE SURFACE

CENTER LINE HEIGHT OF UNIT 12½'

REMARKS: A SLIGHT, CHILLY BREEZE WAS STRIKING THE SIDE OF THE UNIT ON WHICH THE READINGS WERE TAKEN.

ILLUSTRATED DRAWING OF UNIT



TIME UNIT STARTED	TIME TEST STARTED	TIME TEST ENDED	ELAPSED TIME	WEIGHT OF FUEL AT START OF TEST	WEIGHT OF FUEL AT END OF TEST	WEIGHT OF FUEL CONSUMED	POUNDS PER HOUR	GALLONS PER HOUR	TIME TEMP. TAKEN	TEMP. OF SURROUNDING AIR	TEMPERATURE OF RADIATING SURFACES AT THERMOCOUPLE #1	#2	#3	#4	#5	OIL PRESSURE
8:20	8:32		4 166'			5#	72 1	10.75	8:48	57°	903	1213	1228	1184	1153	34
			8.32'			10#	72 1	10.75	9:05	38.3°	900	1213	1213	1168	1134	
									9:35	37.4						

RADIANT ENERGY MEASURED IN MICRO-VOLTS

TIME		10'	20'	30'	40'	50'	60'	70'	80'	90'	100'	110'	120'	130'
8:34	#1	870	630	350	200	146	110	84	73 7	62.5	55 2	48	44.5	41
8:57	#2	862	640	362	150	130	90	69	53	43	35	31	28	25

READINGS AT 100' DIST.

ELEV.	READINGS
0	37
2'	37
4'	37
6'	37
8'	37
10'	37

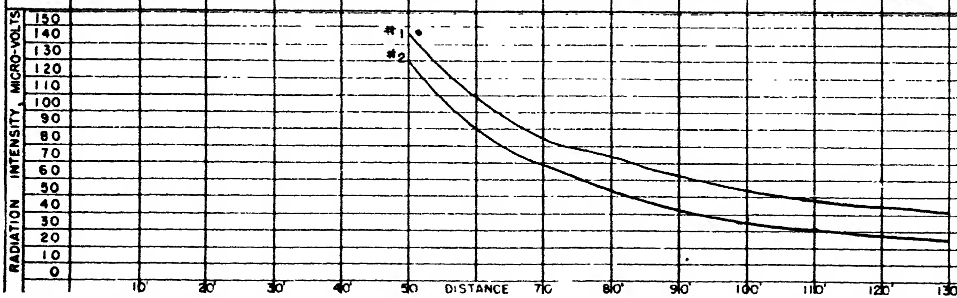


Fig. 3. Performance data for type "B" frost prevention unit. Note the intensity of radiant energy as measured at distances of 10 to 130 feet from the unit.

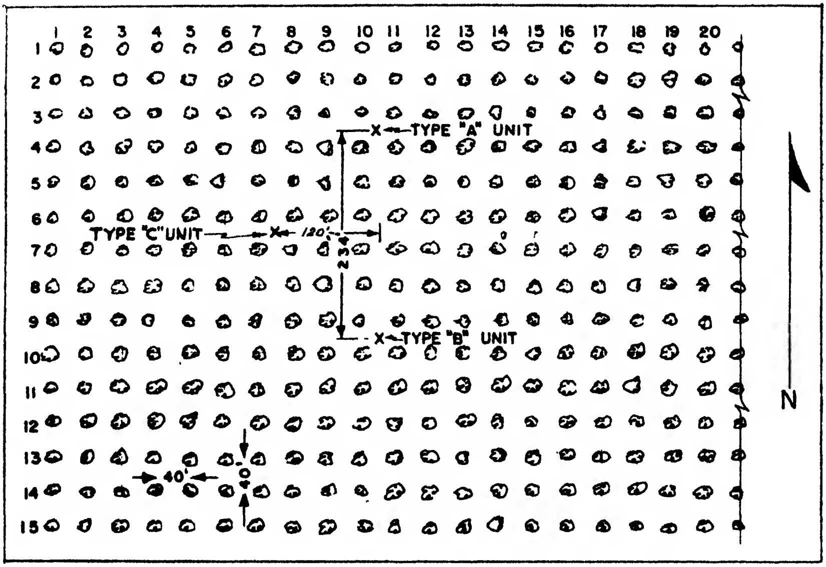


Fig. 4. Arrangement of three frost prevention units in test orchard of apple trees of 15 to 20 feet height. Frost was prevented on trees for a distance of approximately 100 feet from the heaters, with air temperature at 4 feet elevation of 21° F.

set on a triangular pattern between types "A", "B" and "C" units, and Fig. 5 shows a type "A" unit which was one of the heaters used.

It was also found, as previously noted (*Quarterly Bulletin* for November 1946), that temperature of air is not a true criterion of frost prevention when radiant energy is used, since the air itself is not heated appreciably by the wave length of energy used in these tests.

It was noted, however, that even under the low temperature conditions existing during the tests, frost was prevented on practically all branches and twigs for a distance of 100 feet from the units. It was noted, however, that there was frost on the back side of branches of ¾-inch diameter at distances of 60 feet or more from the units. This indicates that there is a problem due to shading, which must be considered. It may be necessary to use somewhat smaller units slightly closer together for trees having dense foliage.

In this test, it was noted that the air temperature at 4 feet elevation surrounding the trees was 21° F. and that the air temperature

at 1 inch above the ground was 33° F. The official weather bureau temperature for the period was 27 F., obviously measured at a high elevation.

It is of note that there was no frost on the ground vegetation (grass) at a distance of 50 feet from the units and only light frost as far as 80 feet; beyond that point was heavy frost. It is considered quite significant that frost was prevented on the grass for a radius of 50 feet with the check air temperature of 3 F.

It was also noted that any dead branches or dry dead grass or

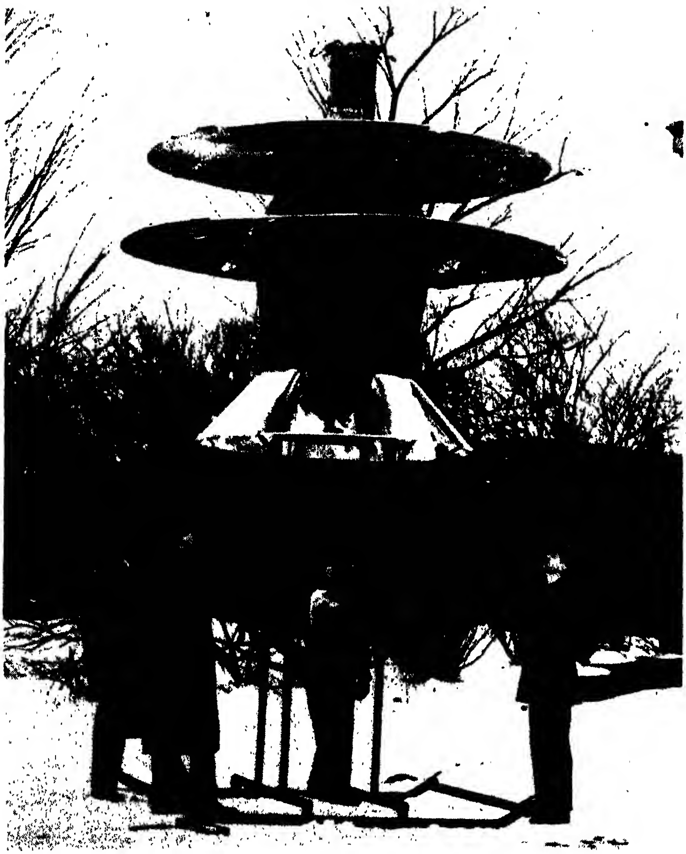


Fig. 5. A second type of frost prevention unit which was also used in the orchard tests.

straw on the ground was heavily coated with frost in some parts of the protected area even though there was no frost whatever on the living twigs and branches.

DISCUSSION

It has been demonstrated that this method will effectively prevent frost on both trees and low-growing crops. Much remains to be done, in finding best methods of using the apparatus, and how best to apply it to different crops.

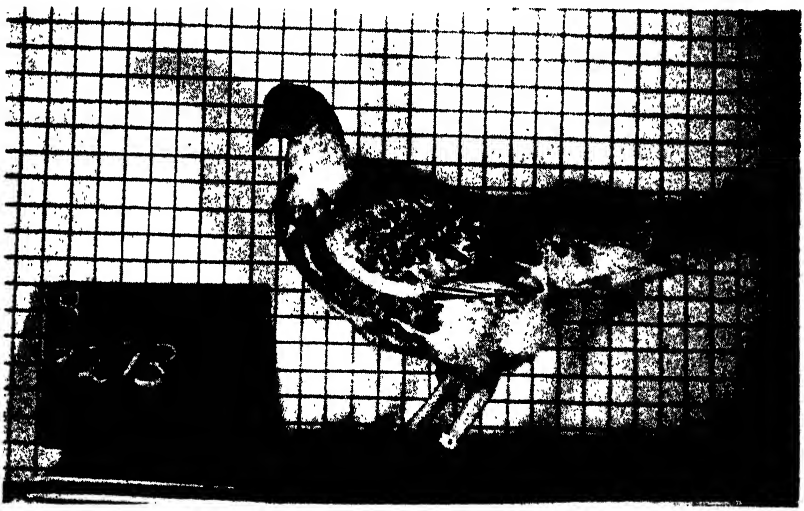
It appears that the area which can be protected sufficiently by one unit, will vary considerably, depending upon the crop, its stage of development and consequent critical danger point, and likewise upon environmental conditions such as topography of land, type of soil cover, atmospheric temperature and humidity, and clearness of sky. Only extensive experiments under these many variable conditions of crop, plant development and environment will establish the effective areas that can be protected from damage by a single unit of a given energy radiating capacity. Practicability for a given set of conditions will vary not only with how much radiant heat will be required per hour per acre but with the number of hours when protection is necessary, and with the value of the crop in terms of the cost of protection. With high-value crops subject to serious damage from low temperatures of short duration protection will undoubtedly be practical.

Further development of the infrared radiant type frost prevention apparatus during the past year has resulted in marked improvement of apparatus, and a determination of many basic principles of design.

A WHITE LACED RED COLOR PATTERN OF CHICKENS FROM A DARK CORNISH X WHITE LEGHORN CROSS

By *EARL W. HENDERSON**
SECTION OF POULTRY HUSBANDRY

A "WHITE LACED RED" (x W.L.R.) plumage color combination appeared in the F_1 female progeny of a Dark Cornish x White Leghorn cross at this station in 1940. The most distinctly marked individual was number 3273a shown in Fig. 1. Since 1940 an appreciable number of (x W.L.R.)** individuals of both sexes have been bred.



The principal objective of the cross breeding project in which number 3273a appeared was to determine the mode of inheritance of meat type. Plumage color therefore was a matter of secondary interest.

*Research Assistant in Poultry Husbandry. Research Associate J. A. Davidson assisted in feeding and management of flock.

**"x W.L.R." is used as an abbreviation for "Crossbred White Laced Red."

ARTICLE 30-6

It seemed possible that the unusual x W.L.R. color pattern might have greater value if it were sex linked. It is well known of course that sex-linked colors such as black and white barring or "silver" can be used in identifying the sex of chicks at hatching time if the females are crossed with males of such breeds as the Rhode Island Red, Dark Cornish, or Brown Leghorn. The last two varieties mentioned are known genetically as "Black-Red" color types. The males from Black-Red and Silver crosses are distinctly lighter in color than their sisters. Even if x W.L.R. is not sex linked it might be useful as a base color for establishing a sex-linked strain in the way that the Cambars [1], Ancobars [2], and Oklabars [3] were developed.

A NEED FOR TESTS OF SEX LINKAGE

The writer has seen no publication of experiments with the White Laced Red color pattern that indicate whether it is sex linked. A test for possible sex linkage seemed to be the first logical step. Little is known also about the inheritance of "lacing" and "pencilling". A White Laced color pattern exists in at least one breed. The late W. H. Card (4) reported establishment of the White Laced Red variety of Cornish from a cross of a White Cornish sire to a dam which he described as "one-quarter Shamo Jap Game, one-half Dark Cornish and one-quarter Brahma". He did not specify whether the Brahma was of the light or dark variety. From unpublished experiments with White Cornish at this station it was surmised that the "white" of White Cornish is like that of the White Leghorn, genetically.

THE TEST FOR SEX LINKAGE

As previously indicated, the procedure for testing sex linkage is simply that of mating the x W.L.R. females to Red, Black-Red, or Brown males. If the white of the x W.L.R. is sex linked the male progeny will be considerably lighter in color than the females. Although facilities were limited, progeny were obtained from thirty-one females scattered among fifteen different matings. The distribution of colors and sexes is indicated in Table 1.

The eventual adult color of the chicks from the cross indicated in Table 1 is not apparent at hatching time. In fact, the color patterns are not too clear before the 16th week of age. In most cases they were not classified until that age. A few males may have been mar-

TABLE 1—*Distribution of colors and sex of progeny of brown-red males x (x W.L.R.) females*

Sex	x W.L.R.	White ticked		Brown	Totals
		Red ticks	Black ticks		
Males	7	20	6	44	77
Females	25	13	10	44	92
Total	32	White ticked 49		88	169

Total "whites" 81
Total "browns" 88

keted at 12 weeks of age before their color patterns were classified, for there are more females than males in the total. Males of the black-red class are easily identified at 12 weeks, but red-ticked birds of both sexes do not develop definite patterns, always, at that age.

The colors of the day-old chicks from the brown x W.L.R. cross are mostly brown or white as a rule with very few black or blue. The brown chicks are quite like the Brown Leghorn or Dark Cornish and develop almost invariably into typical "Brown-Reds". The "white" chicks vary considerably in the amount of black spotting or "ticking" and pink spotting. The base color varies from clear chalk white to dark golden yellow. Some "white" chicks have a distinct pinkish cast. Some of the pink chicks have distinct longitudinal light red stripes on their backs. These may or may not develop into x W.L.Reds and they are just as likely to be one sex as the other.

It is evident from Table 1 that the x W.L.R. color pattern is not sex linked. There is a slight predominance of males in the red-ticked group as compared to the black-ticked group, but there are almost as many females in the entire white-ticked class. There are equal numbers of males and females in the brown class. If all the "white" birds are grouped, that is, both the white, red and black ticked and x W.L.Reds are added together the females in the "white" class exceed the males (33 males—48 females). The segregation of the red and black-"ticked" whites in Table 1 was not considered constant or entirely complete. In some cases the white birds had both black and red spotting. Such a segregation may or may not be warranted.

SOME GENERAL OBSERVATIONS

There is some indication that the white of the x W.L.R. color pattern, in some individuals, is similar to the white of splashed white Andalusians. This is surmised because a few blue-laced individuals have appeared among the crossbred progeny. That the white of some individuals in the white-ticked class is similar to the white of the White Leghorn is indicated by the fact that it masks barring and black. Black and white-barred individuals have appeared occasionally from crosses of white-ticked birds. The barring is seldom of the sex-linked type like that of the Plymouth Rocks but is like that reported for the Silver Campines. In at least one case however, the barring extracted from a Dark Cornish x White Leghorn cross has been proved sex linked. Whether the barring extracted from the Dark Cornish x White Leghorn cross were sex linked or not would depend of course upon its ancestry.

POSSIBLE GENETIC EXPLANATION OF x W.L.R.

An accurate genetic explanation of the x W.L.R. would require definite information about the genes of the parent stock for color. This information is not available especially for the White Leghorn. The dominant white of the Leghorn functions as a mask which inhibits most, if not all colors, and obscures color patterns. To test any substantial number of White Leghorns for color genes requires facilities not available to us. The genetic composition of the White Leghorns we worked with can be surmised only from previous reports. All that seems certain about the White Leghorn parents is that they were invariably white when mated among themselves. The various colors, and patterns which may have been obscured were unknown except for the colors uncovered in this investigation. White Leghorns may vary considerably in the color genes they carry under their white masks.

The genetic constitution of the white of White Leghorns is explained by most investigators as resulting from a single gene "I" which inhibits color. Punnett as early as 1923 suggested that the White Leghorn might be white because it carried two genes which inhibited color. He suggested one is (Silver) "S", which inhibits red or "gold" and the other the (Inhibitor) "I" which inhibits black. He

obtained nearly white birds when he crossed a black and white-barred variety (Silver Campines) with a yellow and white-barred variety (Chamois Campines).

COLOR PATTERNS COMMON TO MOST BREEDS

It is well known that colors of domestic fowl are distributed in patterns which are more or less common to all breeds. The Golden Laced Wyandotte differs from the Silver Laced in that the "gold" or buff center of the feather is replaced by white. In the case of the White Laced Red, the center of the feather is a deep shade of "gold" or "red" and the black lacing is converted to white possibly by a gene which inhibits color in the laced section. Whether the inhibitor is the Silver (S) gene or the Inhibitor (I) gene was not known.

In Dark Cornish the females usually have alternate black and brown or "reddish" brown pencilling. In most the feathers have only one pencil or laced edging. Such may be regarded as "black laced reds". The simple addition of an inhibitor for black may account for a "white laced red". Crossing a Dark Cornish male to a White Leghorn female would introduce an "inhibitor" gene which might mask the black with white, and produce a "white laced red".

BACK CROSS TO RECESSIVE

One well known procedure in establishing the genetic status of a gene complex is to back cross the F_1 (heterozygous) progeny to the recessive, and tabulate the several colors or phenotypes. An expected ratio in the case of one alternate pair of genes is 1:1 i.e. equal numbers of dominant and recessive phenotypes. In the case of the Dark Cornish and the x W.L.R. cross equal numbers of dark or brown colored progeny and white progeny might be expected if only one pair of genes were involved. The ratio obtained from the numbers in Table 1 (81-88) is approximately 52 percent brown, 48 percent white if the x W.L.R. may be included as a "white", which merely has a gene for "lacing" which restricts the red ticking into a definite pattern. There may be a descrepancy in the numbers in the black-ticked class. Deficient facilities forced rigid culling (in the general flock), and some males may have been culled from the range without classification as soon as it seemed obvious they were

not x W.L.R. Selective loss of the white birds to predators or sex-linked genes for viability might be imagined but our information and numbers are hardly great enough to warrant it. The slight predominance of males in the red-ticked class persists however in two additional types of matings to be shown in tables 2 and 3.

PARTIAL EVIDENCE OF WHITE LEGHORN COMPOSITION

Evidently few, if any, of the parental dams among the Leghorns used in our crosses carried silver. It does not seem to be a component of the white portion of the white-laced red feathers. If the white of white-laced red carried silver there should be a much higher proportion of males among the whites and relatively few among the browns. In fact, the appearance of the red-centered feathers may be evidence of the lack of the silver gene. Apparently, the color which was blocked out in the laced edge of red feathers was not red obscured by silver but black obscured by the Inhibitor gene "I". Additional proof of this theory may be obtained by mating the x W.L.R. to Silver Laced Wyandottes. If the progeny from such a cross proves to be nearly all white the theory would be confirmed.

NUMBERS NECESSARY FOR GENETIC ANALYSIS

For a genetic analysis when a large number of genes are involved a relatively large number of progeny are necessary to insure the appearance of all the phenotypes. Where three pairs of genes are involved the minimum number of progeny which should be available for classification is 64. Where four pairs are involved the number of progeny should be 256. The White Leghorn alone is known to possess many more than four pairs of color genes; therefore, our data are not considered adequate for a complete analysis. The greatest number of progeny we obtained was 169.

INHERITANCE OF x W.L.R.

The behavior of the crossbred white-laced reds genetically has not been completely established. Card 4 reports that he "fixed" the W.L.R. Cornish color pattern more or less by back crossing a White Laced Red sire to his pullets for five succeeding generations.

The distribution of progeny obtained from mating x W.L.R. among themselves is shown in Table 2.

TABLE 2—*Distribution of colors (x W.L.R.) x (x W.L.R.)*

Sex	W.L.R.	White ticked		Brown	Barred*	Totals
		Red ticks	Black ticks			
Males	9	16	5	9	2	41
Females	8	7	5	9	1	30
Totals	17	23	10	18	3	71
Totals	17	33		18	3	71
Approximate proportions	1	2		1		

*Chick down color is black.

Ratios obtainable from Table 2 are approximately 1 (x W.L.R.): 2 White (ticked):1 Brown if the barred birds are ignored. Such a ratio is characteristic when a single pair of genes is involved. The explanation is not that simple because some of the x W.L.Reds also carried barring which was obscured by the Inhibitor gene.

The reciprocal of the Brown-Red x (x W.L.R.) cross is interesting primarily because there are no males or females in the black-ticked class. There were 8 black and white-barred chicks all of which were males. When Brown Leghorns were the dams in one mating no blacks appeared. The sire used in this case was from an F_1 red-ticked dam by a Dark Cornish male. The distribution of the colors of the progeny from a cross of a x W.L.R. male to Brown-Red females is shown in Table 3.

TABLE 3—*Progeny from x W.L.R. x brown-red*

Sex	W.L.R.	White ticked		Brown	Barred	Totals
		Red ticks	Black ticks			
Males	5	12	-	18	8	43
Females	19	6	-	19	-	44
Totals	24	18	-	37	8	87
Totals	("White" + (x W.L.R.) 42			37		79

NEW CONCEPTIONS SUGGESTED

The variable colors obtained from the F_1 crossbred White Laced Reds when mated among themselves suggests that a new conception of what constitutes genetic phenotypes and genotypes in poultry may be warranted. More specifically, instead of regarding the entire color complex of an individual bird as a phenotypic or genotypic unit it may be found that the scope of some genetic factors is limited to certain portions of the surface anatomy or parts of the individual feathers. It seems possible also that the expression of some genes may be dependent upon their association with other genes for feather pattern, or vice versa. Similar ideas have been suggested by Serebrovsky (6).

A more specific characterization of color phenotypes may be necessary. As an example, the Brown Leghorn is generally regarded as an example of primitive or "wild" color, comparable to the agouti color of certain mammals. Punnett (1) has designated the color of Brown Leghorns as "brown", Brown-Red and also as "colored". Serebrovsky (6) has designated the gene for the black part of the "brown" as "Tinc". Others describe the Brown Leghorn as a "brown-red". While the Brown Leghorn is described as "brown" or "brown-red" it actually has many other colors. Even white may be found below the surface along with blue or slate. Purple or red is found frequently on the wing bows of males. It seems possible that the "obscurity" of certain colors is relative or partial and not absolute. Relative absence may be due not to lack of a single gene but to the lack of a sufficient number of genes for expression of a color such as white. In other words, some colors in poultry may be dependent upon multiple rather than single genes. If a Brown Leghorn which carries white as an "impurity" were mated to another with the same "impurity", progeny with a little more white might result. Graduated variability in a number of other characters in poultry seems to support such a theory. Progeny have been observed in our experiments which varied all the way through from clear white, "dirty" white. grey, slate blue, blue-black, to black. The same relative variability appears in other colors and patterns.

WHITE LACED REDS AS A NEW DUAL PURPOSE BREED

It should be possible to increase the purity of the white laced red color patterns in succeeding generations by repeated matings of

this variety after the procedure used by Card (4). The percentage of "off-colored" birds to expect in the early stages of a white laced red breeding program is indicated in Table 2. Stock to be used for this purpose may be tested by mating to Brown Leghorns. Those which yield the highest percentage of white-laced red progeny should be best for breeders.

SUMMARY AND ABSTRACT

A non-sex-linked White Laced Red (x W.L.R.) plumage color of domestic fowl occurred among the progeny of a Dark Cornish x White Leghorn cross. The white of the lacing is presumably of the (I) type which masks black and barring. The F_2 progeny is approximately 22 percent x W.L.R., 26 percent white (with red and/or black ticking), 49 percent brown-red, and 3 percent barred from a reciprocal back cross x W.L.R. x Brown-Reds or x W.L.R. X x W.L.R. The F_2 progeny from the x W.L.R. X x W.L.R. cross is approximately 25 percent x W.L.R., 46 percent white ticked, 25 percent brown, and 4 percent black and white. Graduated variability in color and patterns suggested a multiple gene basis for phenotypes.

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CHEMICAL GARDENING FOR THE AMATEUR

By HERBERT C. BEESKOW
SECTION OF BOTANY AND PLANT PATHOLOGY

THE GROWING of plants without soil is not new. In recent years many articles written by over-enthusiastic authors have appeared in the popular press, which have led the general public to believe that soilless agriculture or "hydroponics" may revolutionize modern agriculture.

Agricultural experiment stations, colleges, and universities have received thousands of requests for information regarding this "new" method of growing plants. At Michigan State College inquiries have come from scientific investigators, commercial growers, special military personnel, and from amateur experimenters. By far, most requests for information have come from the latter group and it is expressly for the amateur that this article was written. Individuals who wish more detailed information on the subject of hydroponics should consult the references cited at the end of this article and also the many scientific publications which have appeared on the subject of mineral nutrition of plants in the more technical journals.

It is true that soilless agriculture is quite justified in cases where soil is at a premium or where there is danger of vegetables carrying soil-borne germs which would produce human disease. Certainly, in Michigan, this method is most applicable to greenhouses. Under no circumstances, even in the greenhouse, should the grower abandon his time-tried methods of growing plants in favor of hydroponics without a thorough understanding of the mineral nutrition of plants. Preliminary experimentation on a small scale is strongly advised.

THE MINERAL REQUIREMENTS OF PLANTS

The ash resulting from the burning of plants consists of a mixture of many mineral substances such as calcium (lime), potassium (potash), magnesium, nitrogen, phosphorus, sulfur, iron, and many others. The relative quantities of these elements varies with the species of

ARTICLE 30-7

plant and with the conditions under which it was grown. Most of the mineral elements have certain functions in the plant. Some enter into the construction of the cell walls and of protoplasm. Others take part in the numerous vital activities within the plant such as photosynthesis, respiration, transportation, cell division, etc.

The mineral elements found in the plant are absorbed by the root from the soil. These elements exist in the soil partially in solution but largely in insoluble forms which are slowly made soluble by the slow decay of soil minerals, the action of soil bacteria, molds, etc., and by the life activities of the roots themselves. Chemical elements must be in solution before they can enter the plant.

To a great extent, the growth and development of the plant is a reflection of its environment which consists of a constantly changing interplay of such factors as light, temperature, moisture, available minerals, etc. In soilless agriculture an attempt is made to satisfy the mineral and water requirements of the plant but the other growth factors such as light and temperature are assumed to be favorable for best growth.

Since the plant absorbs the mineral elements from the soil in a soluble form, it is reasonable to assume that good growth may be obtained if the required mineral elements were supplied to a sterile soil, such as sand, in the best possible concentration and balance. This is precisely the object of soilless agriculture. In simple terms, the plants are grown on some inert substance such as sand, cinders, gravel, excelsior, or water, to which is added a mixture of the salts required by the plant. There are many methods of growing plants by hydroponics and only the more common ones will be discussed here.

THE CHIEF FUNCTIONS OF THE MINERAL ELEMENTS IN GREEN PLANTS

A knowledge of the part which the various elements play in the life of a plant will help the amateur in planning experiments and in interpreting his results.

Most of the chemical elements found in plants have certain functions. Some elements appear in many parts of the plant and may function in many different ways whereas others are found in localized areas and play only definite and specific roles. Briefly, the chief functions of the major mineral elements are as follows:

(a) **Calcium:** Calcium or "lime" is necessary for cell wall formation. If it is deficient, the young growing parts of the plant become distorted and new growth is seriously retarded. Calcium forms part of the living membranes of plants and, consequently, regulates the taking up of nutrient elements by the plant. It also helps in maintaining the proper acid balance in the cell and the proper functioning of plant protoplasm.

(b) **Potassium:** This element regulates the transportation and storage of sugars, starches, and other carbohydrates in the plant. It plays a part in cell division and in photosynthesis. Plants which are deficient in potash frequently have leaves with dead margins.

(c) **Magnesium:** Magnesium is part of the chlorophyll molecule. If magnesium is deficient, the lower leaves of the plant become yellow between the veins. Since chlorophyll is necessary for photosynthesis, it is apparent that a deficiency of magnesium will interfere with the productivity of the plant.

(d) **Phosphorus:** Phosphorus is very important in many vital activities of the plant, such as cell division, membrane action, respiration, and the formation of fats. Without an adequate phosphorus supply the maturity of the plant is delayed and seeds fail to form. The leaves of some plants that are deficient in phosphorus will frequently become dark green and turn red on the under side.

(e) **Nitrogen:** This element is found in all proteins, which are the characteristic ingredient of protoplasm. With a deficient supply of nitrogen the plant becomes stunted, matures early, and the yield is very much reduced. The older leaves turn yellow and die if nitrogen is deficient. Too much nitrogen in the nutrient solution leads to excessive succulence, leafiness, and to delayed maturity.

(f) **Sulfur:** This element is essential because it is also found in proteins. Roots do not develop properly in a sulfur deficiency.

(g) **Iron:** Iron is necessary for the formation of chlorophyll. When iron is deficient the younger parts of the plant tend to become yellow. Iron is seldom deficient in soils.

(h) **Boron:** This element has received considerable attention in recent years. Being necessary in only minute quantities, it is considered one of the minor elements. Its exact function is not definitely known. Since it plays some part in the formation of new cells, plants

produce malformed growing points and discolored, dead areas in the stems and roots when boron is deficient.

(i) **Minor Elements:** Besides boron there are many other so-called minor elements which are essential for the growth of the plant. They are necessary in only minute quantities. Such elements as zinc, copper, manganese, and others have been found to be important in plant life, but it is not definitely known how they function. Only rarely are these elements deficient in soils.

SOLUTIONS USED IN SOILLESS PLANT CULTURE

It is impossible to recommend a single nutrient chemical solution which is satisfactory for all kinds of plants grown under all conditions of light and temperature. Furthermore, the requirements of plants change with the age of the plant. Ordinarily a chosen solution may be used throughout the life of the plant. In hydroponics one may hasten maturation by increasing the phosphate in the solution, or the vegetative growth may be increased by the addition of nitrate.

The major mineral elements listed above are supplied to the plant in the form of various chemical salts. These salts may be potassium phosphate, magnesium sulfate, and calcium nitrate, or potassium sulfate, calcium nitrate, and magnesium phosphate, or many other combinations. Iron is necessary in only small quantities and is usually added to the solution in the form of ferric chloride or ferric tartrate. Some investigators recommend adding potassium nitrate to the solution to insure a sufficient supply of nitrogen. The use of ammonium sulfate and other salts is also recommended by some investigators.

The chemicals used may be of the "pharmaceutical" variety and need not be of the "chemically pure" grade. They can usually be obtained from the larger drug stores and chemical supply houses for nominal sums. If one uses the "cinder" method of growing plants, no special concern need usually be given to the minor elements since cinders usually contain sufficient amounts of boron, manganese, etc. If, however, there is any doubt as to the presence of the minor elements, they should be added in extremely small quantities as indicated below.

Many formulae for nutrient solutions have been tried. A partial list of formulae used by various investigators is presented below. The

amateur experimenter may use any of them or he may modify them according to his own desires. Most plants can tolerate a moderately wide range of concentration of salts. It is, however, very important that a proper mineral balance or ratio between the elements is maintained. Many mineral elements may become toxic if certain other elements are deficient.

The weights given here are in the metric system and in the approximate avoirdupois equivalents. If a scale or balance is not available one may assume that one ounce is equal to approximately two level tablespoonfuls. This method of measuring out the salts is, of course, very crude, but it is satisfactory for very rough work. A liter is equal to approximately a quart. There are about 28 grams in an ounce.

Knop's Solution

Calcium nitrate, $Ca(NO_3)_2$	0.8 gram	1 ounce
Potassium nitrate, KNO_3	0.2 gram	¼ ounce
Potassium phosphate, KH_2PO_4	0.2 gram	¼ ounce
Magnesium sulfate, $MgSO_4$	0.2 gram	¼ ounce
Water	1 liter	10 gallons

New Jersey Solution

Potassium phosphate, KH_2PO_4	12 grams	½ ounce
Calcium nitrate, $Ca(NO_3)_2$	40 grams	1½ ounces
Magnesium sulfate, $MgSO_4$	21 grams	¾ ounce
Ammonium sulfate, $(NH_4)_2SO_4$	4 grams	⅛ ounce
Water	10 gallons	10 gallons

Purdue Solution

Magnesium sulfate, $MgSO_4$	10 grams	⅜ ounce
Double super-phosphate, CaH_2PO_4	12 grams	½ ounce
Potassium nitrate, KNO_3	32 grams	1 ounce
Ammonium sulfate, $(NH_4)_2SO_4$	10 grams	⅜ ounce
Water	10 gallons	10 gallons

Gericke's Basic Formula (from "Complete Guide to Soilless Gardening")*

Potassium nitrate, KNO_3	1.010 grams	1½ ounces
Calcium nitrate, $Ca(NO_3)_2$	.164 gram	¼ ounce
Double super-phosphate, CaH_2PO_4	.234 gram	⅜ ounce
Magnesium sulfate, $MgSO_4$	.120 gram	⅛ ounce
Water	1 liter	10 gallons

*With permission of Prentice-Hall, Inc., New York.

M.S.C. Solution

Calcium nitrate, $Ca(NO_3)_2$	30 grams	1 ounce
Potassium nitrate, KNO_3	8 grams	¼ ounce
Potassium phosphate, KH_2PO_4	20 grams	¾ ounce
Magnesium sulfate, $MgSO_4$	15 grams	½ ounce
Water	10 gallons	10 gallons

Iron Solution (to be used with any nutrient solution)

Iron tartrate	50 grams	1¾ ounces
Water	1 quart	1 quart

Add the iron solution at the rate of about 10 ml. (⅓ fluid ounce) per gallon of nutrient solution. Add more if the plants turn yellow.

Minor Element Solution (to be used with any nutrient solution)

Boric acid, H_3BO_3	1.6 grams	⅛ ounce
Manganese sulphate, $MnSO_4$	1.6 grams	⅛ ounce
Zinc sulphate, $ZnSO_4$	1.6 grams	⅛ ounce
Copper sulphate, $CuSO_4$	0.3 gram	1/64 ounce
Water	1 liter	½ gallon

Add about 20 drops of the minor element solution per gallon if there is any question regarding the presence of minor elements in the cinders.

DIRECTIONS FOR SETTING UP THE CHEMICAL GARDEN

There are many ways of growing plants in chemical solutions, and only a few of the methods will be described here.

Water Culture Method

In this method the young seedlings are suspended on a support and the roots are submerged in the nutrient solution. For this method the amateur experimenter may use some of the common articles found in the kitchen. A dishpan or crock and a wood cover are all that are necessary. Drill holes in the wood cover of a size depending upon the kinds of plants to be grown. Spacing should also be kept in mind. It is best to drill more holes than are necessary and use only a few of them. After the holes have been drilled the board should be thoroughly impregnated with paraffin. This is best done by heating it in an oven for a few minutes and, while hot, painting it with hot paraffin. Asphalt paint may also be used.

The seeds are germinated in sand or sandy soil. To prevent damping-off, the sand must not be too wet. When the seedlings are about one or two inches tall, wash them carefully from the sand and

insert them in the holes in the wood cover. The seedlings may be supported in the holes by means of a small tuft of cotton. Fill the container with the nutrient solution and be sure the roots are submerged. Place the set-up in a sunny place. Keep in mind that light is of utmost importance in the life of green plants. Remember that the light intensity in even a well-lighted room is only a small fraction of the intensity of bright sunlight. As the plants get larger it may be necessary to support them in some way.

Since air is an important factor in the development of roots, it is necessary to devise some way of aerating the nutrient solution at least once a day. An ordinary aspirator or a tire pump may be adapted to this purpose. If these are not available, pour the solution into a large bottle and shake it vigorously for a few minutes daily.

Naturally, the solution will become contaminated and depleted as time goes on. About every 2 weeks (more or less, depending upon the size of the plants) discard the old solution and replace it with a fresh one.

The method described here has been found to be satisfactory for many garden vegetables and flowers. It can be used for hyacinths and certain daffodils if the bulbs are set about a half inch above the surface of the solution.

The size of the tank may be modified to suit the experimenter's wishes. If desired, a large Mason-type jar may be substituted for the dishpan and a large cork for the wood cover.

Tray Culture Method

The tray culture method is better but a little more involved than the preceding one. Any sized tank may be used but it should be about eight inches deep. If the tank is constructed of copper, zinc, or lead, is should first be painted with asphalt paint before using it. Tanks may also be constructed of wood and made water-tight with tar-paper. The tank should have a hole in one end for drainage. Construct a wooden frame to fit inside the tank and cover the frame with fine mesh chicken wire or ½-inch hardware cloth. It is advisable to paint the wire and frame with paraffin.

Suspend or support this screened frame in the tank so that it rests about 2 or 3 inches below the top of the tank. If a small tank is used it is not necessary to build a wooden frame. Simply bend the screen so that it forms a tray and hangs from the sides of the tank. Cover

the screen with excelsior, sphagnum moss, or glass wool or similar material. In the early stages of growth the excelsior must be kept moist. Later, after the roots have extended into the solution about 2 inches, the excelsior need not be kept wet and it is recommended that an air space of about one inch be allowed between the screen and the surface of the nutrient solution. If the excelsior is kept too wet, it may become contaminated with molds and algae.

The tray method may be used for most plants. Seeds, bulbs, corms, cuttings, etc., may be planted directly into the excelsior. If small seeds are used it is best to wrap them first into a few folds of tissue paper and bury the paper in the excelsior. The seeds must be kept moist but should not be submerged in water. In using this method it is also necessary to aerate the solution frequently. It must be remembered that roots are alive and need oxygen for their growth and proper functioning. The solution should be discarded about every 10 days or 2 weeks and replaced with a fresh solution. It is advisable to wash the tank when the change is made.

The Cinder or Gravel Method

The cinder method is the one most commonly used by commercial growers and is easy to manipulate. Essentially, it consists of growing the plants on some inert substance like cinders, sand, gravel, lava ash, etc., which is kept moist with the nutrient solution.

The tanks used may be of any convenient size but should be about 6 or 8 inches deep. Some investigators have made culture tanks of flat wooden boxes which are lined with tar-paper to make them watertight. No cover of any kind for the culture tank is needed. A hole must be provided at one end of the tank for drainage. Instead of supporting the plants on a screen they are grown directly in the cinders or gravel. If cinders are used they should be sifted to remove the particles smaller than ¼ inch. Cinders larger than one inch in diameter should be removed also. It is best to use cinders which have been exposed to the weather for about a year. If they are not weathered, they should be sprinkled with 10-percent hydrochloric (muriatic) acid or 10-percent sulfuric acid. The acid must be washed off before the cinders can be used. Most glacial gravel is good for this method. Do not use crushed limestone. Coarse quartz sand is excellent. In some areas of the country crushed volcanic ash is found to be very satisfactory.

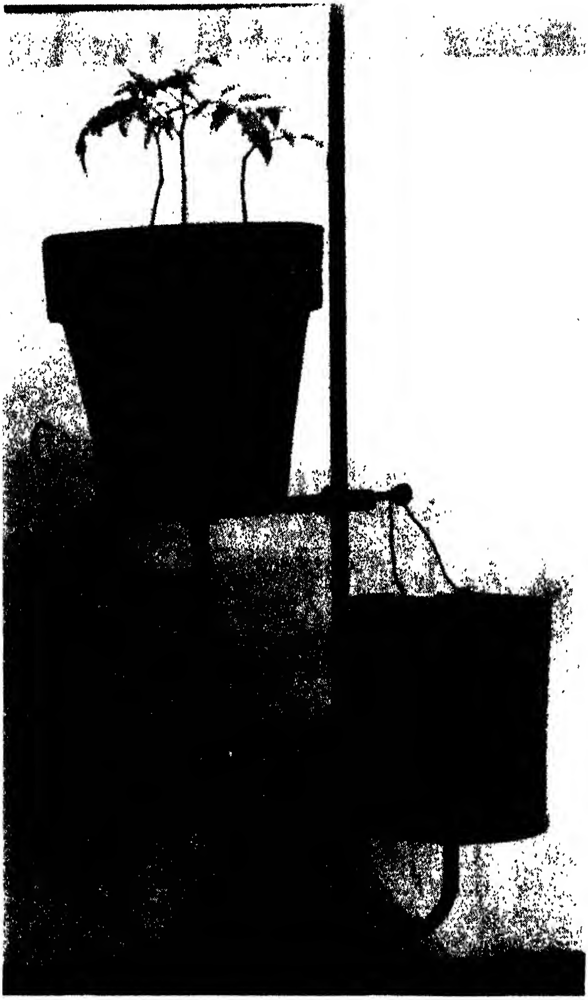

Fig. 1. (Simplified Method 2). The flower pot is filled with cinders or gravel. The pail contains the nutrient solution. To irrigate the cinders the pail is raised above the level of the flower pot. When the solution has completely drained into the flower pot the pail is again lowered. The cinders are flushed in this manner daily.

Fill the tank with the cinders and flood with the nutrient solution. Let the cinders soak for about a half hour and then drain the solution into a tank, barrel, or large bottle. Be sure the tank drains

completely. Plant seeds, cuttings, or bulbs, directly in the cinders. If small seeds are used wrap them first in a few folds of tissue paper.

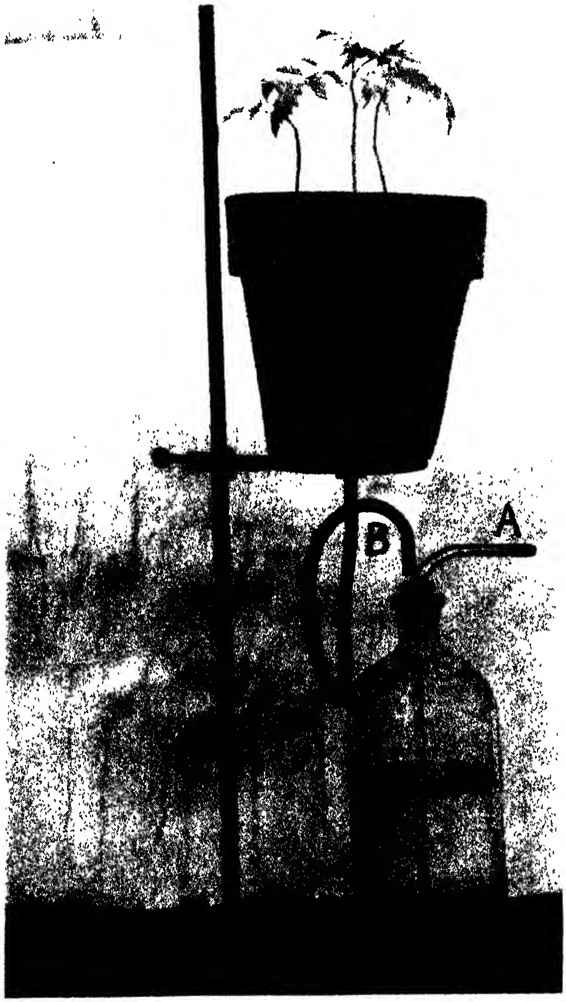

Fig. 2. (Simplified Method 3). The rubber tube (B) is connected to a glass tube which extends to the bottom of the bottle. Glass tube (A) extends just below the stopper. To flush the cinders or gravel in the flower pot pressure is applied to tube A. When the cinders have been completely flooded the pressure is released and the nutrient solution is allowed to flow back into the bottle.

Once a day pour the solution back into the tank and flood the cinders. After a few minutes, drain it off again. If a large tank is used it may be necessary to use a pump to bring the solution back into the growing tank. Replace the evaporated water with tap water. In using the cinder method it is very likely that the solution will become somewhat alkaline. The solution may be tested with litmus paper or similar acidity indicators. To neutralize the solution add a few drops of 10-percent hydrochloric acid or 10-percent sulfuric acid. Add two or three extra drops per gallon after neutrality has been reached.

Simplified Methods

If the experimenter wishes to grow plants on a very small scale. one of the following methods may be used:

Method 1 – Insert a rubber or cork stopper into the hole of a large flower pot. Fill the pot with washed cinders and flood them with the nutrient solution for a few minutes. Remove the stopper and allow the solution to drain into a wide-mouthed bottle or a crock. Plant seeds, seedlings, cuttings, or bulbs directly in the cinders as described above and repeat the flooding process daily by pouring the solution directly over the cinders. Add water if the cinders are not completely flooded.

Method 2 (see Fig. 1) – Use a large flower pot or similar container with a hole in the bottom. Also provide a pail with a hole in the bottom. Connect the two holes with a flexible rubber tube as illustrated. Hang the pail at a level above the flower pot. Fill the flower pot with washed cinders and flood with a nutrient solution. Allow to soak for a few minutes. Now lower the pail and let the solution drain into it. To flush the cinders simply raise the pail. This operation is repeated every day. Do not flood the cinders longer than five minutes.

Method 3 (see Fig. 2) – In this method a flower pot and a large bottle are necessary. The bottle should be provided with a two-hole stopper as illustrated. By means of glass tubing and a flexible rubber hose the solution from the flower pot is drained into the bottle. The glass tube extends to the bottom of the bottle. Through the other opening in the stopper a bent glass tube is inserted which extends just below the bottom of the stopper. Pour the solution into the bottle. To bring the solution into the flower pot air is blown into the bottle by means of a tire pump. When the pressure is released the solution

will drain back into the bottle. This process is repeated daily. Add tap water if the solution becomes depleted. Renew the solution about every 10 days.

PRACTICAL PHASES OF CHEMICAL GARDENS

In working with hydroponics most amateur experimenters disregard the importance of light. Green plants will not develop properly if the light is poor. Hydroponics does not take the place of light.

Large-scale installations of hydroponics are based essentially upon the simple experiments which have been described here. If large growing tanks and reservoirs are used, the solutions may be pumped into the tanks electrically. The pumps may be operated by a mechanical time switch, thereby eliminating any hand labor once the installation has been started.

In general, hydroponics has its greatest possibilities in greenhouses for certain crops. A few greenhouse operators grow flowers and vegetables experimentally by this method. In places where soil is at a premium or where the soil is badly contaminated with human parasitic organisms the method is to be recommended. Large installations of hydroponics have been made on Ascension Island, Wake Island, and other similar air bases. The military forces have also installed large soilless gardens in Japan, Korea, and other oriental countries where vegetables grown on the soil are known to carry human parasites. The method is also good in desert areas. The use of this method for indoor window boxes may prove interesting.

One of the greatest advantages of this method is that the nutrition of the plant can be controlled accurately. With this method it is also possible to change the mineral supply of the plant at any stage of its growth. It is a very valuable research technique.

Most popular literature leads one to think that hydroponics is a simple procedure and requires little labor. Actually more work may be involved than in growing plants in soil. The time and effort used in purchasing the chemicals, mixing solutions, building tanks, changing solutions, and constructing supports should be weighed against the time and effort used in simply watering soil-grown plants daily. Certainly in hydroponics one is not dealing with a simple "push-the-button" method of growing plants. The amateur is encouraged, however, to experiment with hydroponics, but he should not expect miracles to happen.

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TESTS OF THE HORMONE STILBOESTROL AS AN AID IN GREENHOUSE TOMATO PRODUCTION

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IN 1945 Thomas Swarbrick working at the Long Ashton Experiment Station in England, announced the successful setting of tomato fruit by the use of the hormone stilboestrol (4-4′ dihydroxy diethyl stilbene).

Since the application of chemical treatments for increasing fruit set in greenhouse tomatoes has come into rather general use among our growers, and stilboestrol had not been tested here for this purpose, some experiments were undertaken in the spring of 1946 to determine the value of this hormone in greenhouse tomato production.

John Baer tomato plants were grown in the same manner as previously described for other hormone tests (1, 2, 3). The soil was a sandy loam previously steam sterilized. A 3-12-12 commercial fertilizer was applied at the rate of 10 pounds per 1,000 square feet when the plants were set, and a side dressing of ammonium sulfate was used when necessary. Moisture was supplied by ground irrigation. Eighty plants were set 12 inches apart each way with a 2-foot aisle between every two rows. Plants were pruned to a single stem and supported on 1-inch vertical wooden stakes which were fastened above to a series of wires so that tapping or shaking the wires would result in jarring the plants. Pollination of the flowers was accomplished in this manner three or four times each week until May 4.

Stilboestrol was applied on flower clusters as a spray in addition to the pollination treatment mentioned above. Since this chemical is insoluble in water, a solvent is necessary in preparing it for use as a spray treatment. Morpholine which had been successfully used as a solvent in some previous hormone experiments (1) or ethyl alcohol (95 percent) was used to dissolve the hormone, and then the solution was diluted with water so that the resulting concentration of the solvent was 6 percent in the case of morpholine and 70 percent for alcohol. After three applications, the use of morpholine as a solvent

ARTICLE 30-8

was discontinued because better results were secured with alcohol. Stilboestrol was used as a spray at 50 and 100 parts per million.

Vapor treatments were attempted using 500 and 800 mg. dimethyl ether of stilbene. This chemical was vaporized on an electric hot plate in a closed house of 4,000 cubic feet capacity, using an electric fan to provide circulation of the vapor as described for some previous tests (2). The house was left closed for 12 hours after treatment. No epinasty of leaves or growing tips was observed. Plants were not jarred to assure pollination previous to these treatments.

The results of the tests with this hormone are summarized in Table 1.

TABLE 1—*Effects of the hormone stilboestrol on the production of greenhouse tomato fruit*

Treatment	Date	Percentage of clusters set	Average number fruit per cluster	Average time to ripening days	Average weight of fruit in ounces
100 ppm stilboestrol in 70% alcohol	4-10-46	87%	3.3	55	2.8
100 ppm stilboestrol in 6% morpholine	4-10-46	45	1.5	60	3.2
pollinated only	4-10-46	85	3.2	54	3.1
100 ppm stilboestrol in 70% alcohol	4-16-46	97	3.5	54	2.8
100 ppm stilboestrol in 6% morpholine	4-16-46	50	1.6	62	3.0
pollinated only	4-16-46	87	3.3	55	3.2
100 ppm stilboestrol in 70% alcohol	4-19-46	80	2.9	45	2.2
100 ppm stilboestrol in 6% morpholine	4-19-46	55	2.1	60	2.6
pollinated only	4-19-46	84	3.3	48	3.2
50 ppm stilboestrol in 70% alcohol	4-23-46	81	3.2	48	2.1
pollinated only	4-23-46	85	3.3	45	3.1
50 ppm stilboestrol in 70% alcohol	4-26-46	75	2.3	55	2.6
pollinated only	4-26-46	87	2.1	57	3.4
100 ppm stilboestrol in 70% alcohol	4-30-46	73	1.9	52	3.0
pollinated only	4-30-46	74	2.5	50	3.4
100 ppm stilboestrol in 70% alcohol	5- 3-46	77	1.6	55	2.4
pollinated only	5- 3-46	75	2.0	51	2.6
500 mg. dimethyl ether of stilbene vaporized	5-20-46	35	1.7	48	2.6
800 mg. dimethyl ether of stilbene vaporized	5-25-46	38	1.5	47	1.8

This chemical seems to have no injurious effects upon plants or fruit such as are sometimes observed with 2,4-D or beta naphthoxyacetic acid (2, 3). No foliar distortion or misshapen hollow fruits resulted from the concentration of this hormone tested. Flowers so treated did not produce seedless fruit. Treatment with stilboestrol at 50 or 100 p.p.m. did not consistently increase the number of fruit set or the size of fruit over those resulting from pollination alone, nor was the time to maturity of the fruit decreased. Vapor treatments using dimethyl ether of stilbene were not satisfactory in the concentrations tested.

CONCLUSIONS

Although stilboestrol seems to have no deforming effects on tomato foliage or fruit, it is not so effective in inducing fruit set or increasing size of fruit as beta naphthoxyacetic acid or 2,4-dichlorophenoxyacetic acid which have been previously tested and are now being used commercially in greenhouse production.

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COMPOSITION OF THE SOLIDS WHICH DEPOSIT FROM EVAPORATED MILK DURING STORAGE

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DURING PERIODS of storage granular solids form in evaporated milk and settle to the bottom of the container. Statements relative to the chemical nature of such precipitates have been presented in the literature. Sato (6) reported that the solid sediments which form in evaporated milk are composed of tricalcium phosphate, magnesium phosphate, and tricalcium citrate. He also stated that the sediment obtained from sweetened condensed milk contained crystals of tyrosine, leucine, and crystine in addition to the constituents mentioned above. Mojonnier and Troy (5) and Webb, Deysher and Hufnagel (7) have likewise expressed the belief that the solid which precipitates from evaporated milk consists of tricalcium citrate. However, none of the references cited above include a chemical analysis of the precipitate.

Since these precipitated solids constitute one of the major defects of evaporated milk, it was decided during the course of an earlier investigation of evaporated milk (2) to collect samples and analyze them. This was done and the results obtained are reported in this paper.

EXPERIMENTAL AND RESULTS

Samples of the solid deposit were collected from a large number of cans of evaporated milk which had been stored at different temperatures. When a can was found to contain an appreciable quantity of solids, the bulk of the milk was removed, and the solids were washed successively with several portions of distilled water, once with ethyl alcohol, and finally with diethyl ether. After this treatment they were dried for a short period of time at 100° C., cooled, and ground in an agate mortar. This process was repeated until an

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ARTICLE 30-9

adequate supply of the material was obtained. Considerable time elapsed between collection and analysis of the samples, and during this interim they were stored at room temperature in glass weighing bottles.

The samples were analyzed by methods of the Association of Official Agricultural Chemists (1) and other accepted methods. The citrate was determined by suitable modification of the pentabromoacetone method (3, 4). The loss in weight upon heating at 180° C. was taken as the water content.

The constituents determined and the results obtained from duplicate samples, a and b, are given below:

Constituent determined	Percent		
	Sample a	Sample b	Average
Ca^{++}	20.10	19.89	19.98
Mg^{++}	.97	.90	.94
$C_6H_5O_7^{---}$	60.00	60.60	60.30
PO_4^{---}	.64	.64	.64
SiO_2	1.14	1.08	1.11
Protein (N x 6.38)	3.70	3.76	3.73
H_2O	12.56	12.46	12.52
Total			99.21

From the results obtained it is obvious that citrate ion, calcium ion and water are the major constituents of the deposit. This indicates that crystals of tricalcium citrate tetrahydrate, $Ca_3(C_6H_5O_7)_2.4\ H_2O$, which contains 66.3 percent citrate, 21.0 percent calcium and 12.6 percent water, constitute a major portion of the total precipitate. The other constituents are magnesium, phosphate, silica and protein.

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POST-WAR DEVELOPMENTS IN INTERNATIONAL WHEAT MARKETING

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MICHIGAN FARMERS in the fall of 1946 planted the largest acreage of wheat since the turn of the century. In 1947 they are harvesting the largest wheat crop in the twentieth century. Wheat acreage planted has averaged slightly over 800,000 acres since 1930 but rose to 1,175,000 acres in the fall of 1946. Similar increases took place immediately after World War I only to decline later. Are similar declines likely to occur in the years immediately ahead? Farmers will do well to keep their production plans flexible and to watch developments in the wheat markets of the world.

In this connection a recent international wheat conference held in London is significant. The four principal wheat-exporting and 10 principal wheat-importing nations were represented. This conference was called in an effort to set up an international wheat agreement which would maintain certain rules of international trading and which sponsors believed would lead to greater price stability in world markets and greater assurance of market outlets than had been the case before 1940 (1). It was hoped that maximum and minimum prices could be established as well as maximum imports and minimum exports for consuming and producing countries respectively.

Disagreement as to the price ranges to be fixed prevented conclusion of a 5-year wheat agreement, although a draft agreement was prepared. The Argentine delegates believed that any price less than the $2.60-2.75 then existing was too low, while United Kingdom delegates believed that a price range of $1.00 to $1.55 was appropriate (2). The immediate effect of the failure of the conference appears to be a higher export price for the 1947 crop year and, hence, higher prices to United States and Michigan wheat farmers but possibly at the cost of lower prices later.

ARTICLE 30-10

To understand the background of the various proposals and points of view it is necessary to review the major aspects of the inter-war wheat surplus problem. During World War I and the relief period immediately thereafter, wheat production increased in all non-European areas. High prices, the greater use of tractors, combines and other farm machinery, the release of land used to feed horses, and the greater knowledge of dry land farming all operated towards an expansion of wheat acreage in the four major exporting countries —United States, Canada, Australia and Argentina. As shown in Table 1, production in these four countries increased 29 million acres from 1909-13 to 1923-27. Acreage elsewhere decreased 2 million acres leaving a net increase of 27 million acres.

TABLE 1—*Wheat harvested in major producing areas (millions of acres)*

	1909–13 average	1923–29 average	1935–39 average	1946
United States	51	62	74	72
Canada	10	22	26	26
Australia	8	11	13	12
Argentina	16	19	19	17
Europe (exc. USSR)	73	69	77	65
World totals (except USSR and China)	215	242	281	270

Source: Wheat, Commodity Series, Food and Agriculture Organization.

European productive capacity was gradually restored during the twenties. Although pre-war acreages were not attained until 1930, pre-war production was reached in 1925 and again in 1928 and 1929. The difficulties in restoring full international trade and the nightmares of large-scale food shortages fresh in the memories of many people combined to induce greater efforts on the part of many nations to produce a larger part of their own food supplies than before the war. The tariffs and domestic subsidies which were imposed reduced the export markets for United States and other wheats, while improvements in production methods increased acreage and production both at home and abroad.

Moreover, people turned increasingly to the non-cereal foods for their calories and proteins, and required less food as sedentary occupations increased. Per capita consumption of wheat in the United Kingdom decreased from 5.6 bushels in 1913 to 5.2 bushels in 1935-38, in France from 8.1 to 7.1, and in Belgium from 7.3 to 6.2. In the United States wheat consumption dropped from 4.7 bushels per

capita in 1923-26 to 3.7 bushels in 1936-40. Inevitably the result of these trends in production and consumption was a larger total world production which had increasing difficulty in finding a market. World stocks accumulated, reaching 586 million bushels in 1929, more than double the stocks held in 1922-26. During this period various governmental measures were proposed through which it was hoped that foreign markets for United States wheat, cotton and other export commodities could be maintained. None were actually passed into law, although the McNary-Hargen bill passed both houses but was twice vetoed by the President. The Federal Farm Board was set up in 1929 and stockpiled considerable quantities of wheat. It was directed toward price stabilization rather than at maintaining international markets.

READJUSTMENT IN THE THIRTIES

The history of attempts at agricultural readjustment in the thirties is more recent and more familiar. Competitive tariff raising became common in counteraction against increases in United States tariffs and in ineffectual effort to reduce the effects of the world-wide economic depression. Tariffs of a dollar and more per bushel were imposed by various importing countries. World wheat prices as represented by the Liverpool market dropped to 54 cents per bushel in 1932 compared with the $1.25-1.80 price range of most of the twenties. The farm price in the United States was only 38 cents per bushel. Acreage control measures were inaugurated in the United States, aimed at reducing wheat production to the amounts which the world would buy. Other exporting countries followed programs designed to assist their farmers in adjusting to the loss of foreign wheat markets.

The first international wheat conference was called in 1933. Some temporary success was obtained at this conference. Exporting countries agreed to limit exports and reduce production, while importing countries agreed to take steps to increase wheat consumption, not to increase production, and to lower tariffs if internal prices increased. The droughts of 1934-36 aided in reducing stocks and production to manageable proportions, and by 1935 the agreement was inoperative. However, with the all-time record crop of 1938, stocks again began to accumulate. As seen in Table 1, acreage had expanded another 39 million acres to average 281 million acres in 1935-39.

By this time, most of the exporting governments were intervening in the wheat market in such a way as to establish certain more or less definite floors to wheat prices. In most cases wheat was unable to compete with corn for large scale use as livestock feed. Consequently, the several export countries established competing export subsidies in an effort to dispose of their wheat in the small foreign markets remaining. As a result, prices in foreign ports after paying freight and before payment of duty were often less than the price on the domestic market. Conversations started at this time finally led to a wheat agreement in 1942 between the four exporting countries and Great Britain (3). The agreement was of little significance except in indicating intentions. The Conference in 1947 was the outgrowth of this earlier agreement.

WORLD WAR II

During the recent war there was no attempt to increase wheat production in the major exporting countries. In fact efforts were made to shift production to other grains and to use accumulated stocks as supplements to more limited supplies of other grains in increased livestock production. With the end of the war large quantities of wheat were exported for relief feeding. In the United States exports rose from around 50 million bushels in most of the years since 1931 to 389 million bushels in 1945 and over 400 million bushels in 1946-47. (See Table 2.) Prices also rose from less than a dollar a bushel (Chicago) in 1938-40 to present levels of well over $2.00 per bushel (see Table 3).

This background provides a basis for a pessimistic longtime view of wheat price prospects, if previous patterns are to be repeated.

TABLE 2—*U. S. and total world exports of wheat and wheat flour in indicated years* (million bushels)*

	U. S.	World
1909–13	109	678
1923–27	172	784
1930–34	58	664
1935–39	62	574
1940	31	485
1943	70	526
1945	389	880

*Crop years beginning in July for U. S. and August elsewhere.
Source: Wheat: FAO Commodity Series, Food and Agriculture Organization.

TABLE 3—*Price of U. S. Wheat, Chicago 1936-45*
(Annual average price No. 2 Hard Winter)

1936	$1.17	1941	$1.09
1937	1.18	1942	1.26
1938	.70	1943	1.51
1939	.78	1944	1.60
1940	.85	1945	1.67

Source: Agricultural Statistics 1946.

Patently as relief feeding decreases and European agriculture expands its production, less wheat will be exported. Tariff rates are relatively much higher than in 1920 (4), while productive capacity in exporting countries is much greater.

For these reasons, exporting countries have been anxious to negotiate an international wheat agreement so as to prevent a complete deterioration of the world wheat market a few years hence. They do not wish to see a repetition of the chaotic pre-war pattern of tariffs, domestic subsidies, export dumping and production controls.

TERMS OF THE DRAFT AGREEMENT

While the London Conference did not agree upon an international wheat agreement, a draft was prepared which with a few modifications may be the basis for later ratification. This draft agreement is essentially a multilateral bulk purchase contract (5). Export countries guarantee to supply import countries with specified annual quantities of wheat at a maximum price, while import countries agree to accept specified annual quantities at a minimum price. Quantities over and above the specified amount are not subject to the draft agreement.

After the Argentine delegates refused to accept a maximum price limitation, Canada, Australia and the United States jointly undertook to guarantee 500 million bushels of wheat annually to the importing countries, and the importing countries agreed to purchase that amount. The United States was to supply 185 million bushels. The draft agreement provided maximum prices of $1.80 for the first year, $1.70 for the second year, and $1.80 for the last three years of the 5-year agreement. Minimum prices were to be $1.40 the first year, dropping 10 cents per bushel each year to $1 for the fifth year. These prices were applicable to the basic grade Manitoba No. 1 Northern at Fort William, Canada. Adjustments are to be made for other grades and other ports (5). Within these limits price fluctuations could occur

freely. The United Kingdom delegation was unwilling to accept the indicated maximum prices, whereas the United States delegation had insisted on these prices in preference to the $1.55 price contained in the pre-conference draft.

Most of the other parts of the draft agreement were acceptable. These make provisions for legalizing the disposal of surplus stocks at lower prices to needy nations, for defining procedures by which signatory countries may modify their obligations in case of a short crop or exchange difficulties, for maintenance of minimum stocks in export countries and for creating a coordinating, supervisory International Wheat Council.

Discussions as to prices are now continuing in a less formal manner. Great Britain has a contract with Canada providing wheat at $1.55 per bushel and, hence, is unwilling to accede to a higher maximum price. The United States, however, is receiving a higher price at present without an agreement. Negotiations between these two countries probably will determine whether or not the draft agreement with some modifications will be signed and put into operation.

SIGNIFICANCE

It is by no means clear that the conclusion of a wheat agreement would provide the sort of stability envisioned by its proponents. Before the war international commodity agreements of this sort usually supported higher than competitive prices leading to expansion of production in some areas. Countries facing exchange difficulties can reduce their obligations to import wheat, even though signatories to the agreement. There is no provision for reducing tariff barriers and expanding international wheat trade, and thus developing a more logical integration than in the past of the United States-Canada efficient wheat producing areas with the high-cost, subsidized European production.

A further complication occurs in the United States. Under the Steagall amendment the Government is obligated to support wheat prices at 90 percent of parity until January 1947. This support price is just about at the maximum price of the agreement, namely $1.80, applies to a slightly lower quality of wheat but represents farm rather than market prices. If the parity price were to continue increasing rather than decreasing during 1947 the support price would be above the $1.70 maximum price in the second year of the agree-

ment. For the United States the maximum price of the agreement is very close to the minimum or support price. If the parity price increases the minimum domestic price may exceed the maximum international price leading to serious administrative problems. These possibilities certainly will limit the price concessions which the United States can make, and may delay considerably the time when an international agreement becomes effective. It is now unlikely that an agreement will be negotiated before 1948. It may be that part or all of the post-war adjustments of the twenties will be repeated.

Michigan farmers will find it to their interest to watch developments of this kind in international policy. It will be desirable to maintain flexible farm plans in wheat acreage for some years so that they can shift out of wheat and into other crops and enterprises readily. With current production of wheat in Michigan at over 30 million bushels and at the highest level since before the turn of the century, it behooves Michigan farmers to watch developments in the international wheat markets.

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LABORATORY PASTEURIZATION STUDIES ON HOME ELECTRIC MILK PASTEURIZERS

By G. M. TROUT and A. L. BORTREE

SECTIONS OF DAIRY AND BACTERIOLOGY

FOR SOME TIME considerable interest has been shown in the pasteurization of milk in the home. Particularly has there been an aroused interest in the pasteurization of milk on the farm for family use. Recently, electric home milk pasteurizers have been devised which seem to offer much promise for pasteurizing milk quickly and economically under home conditions (1, 2, 4). Previous to the introduction of these pasteurizers several recommendations were made relative to home pasteurization of milk using standard equipment to be found in any home (3). Extensive rural electrification has made possible the use of the newly developed electric home pasteurizers for pasteurizing milk in place of the previously recommended home methods, good as they were.

Inasmuch as electric home milk pasteurizers are being offered the public, it seemed desirable to ascertain the ease and time of operation, the destruction of bacteria, and the effect upon the milk itself. Consequently, studies were made along this line. The results of these preliminary laboratory studies on three machines now available are reported herein.

EXPERIMENTAL PROCEDURE

Mixed herd milk from one or more herds was pasteurized according to directions of the manufacturers of the pasteurizers. Several variations such as might be encountered in the home were introduced. The standard plate counts, phosphatase tests, coliform tests, creaming abilities, and organoleptic examinations were carried out according to standard procedures.

ARTICLE 30-11

RESULTS

Waters Conley pasteurizer

This pasteurizer of one-gallon capacity, shown in Fig. 1, is ably described by Schaenzer and Shiozawa (1) as follows:

> An electric batch pasteurizer is made by Waters Conley Company, Rochester, Minnesota, and marketed by Sears, Roebuck and Co., Chicago, Illinois.
>
> The pasteurizer consists of a base having a 300 watt, 110-120 v., a.c., 50 or 60 cycle heating element with thermostat placed in the bottom of a barrel which serves as a housing and flue to distribute the heat around a 1-gallon milk bucket. Both housing and bucket are made of drawn aluminum. The housing is coated with baked lacquer. The lid of the bucket overlaps the rim so as to shed water when cooling the pasteurized milk. The thermostat is spring mounted to insure good contact with the bottom of the bucket. A thermostatically controlled timer does not operate until the milk has been heated to the pasteurization temperature. A buzzer operates when the timer returns to the "off" position.
>
> When pasteurizing milk, the timer knob is turned to the right as far as possible, the unit plugged into an outlet, and the operation is automatic. When the milk reaches the proper temperature, the heater is turned off and the timer starts operating. If the temperature of the milk drops below 143° F., the thermostat turns on the heater and stops the timer until it is again up to temperature. At the end of the 30-minute pasteurization period, the current is cut off from the heater and a buzzer sounds until the pasteurizer is disconnected.
>
> With a full gallon of milk at 50° F., approximately 1 hour and 15 minutes are required to complete a pasteurization cycle. Smaller quantities may be pasteurized, although less than a quart may heat too rapidly.
>
> It is claimed by the manufacturer that, by locating the heating unit near the edge of the milk container, convection currents are set up in the milk, thus heating it slowly and preventing scorching or localized overheating. The approval of Underwriters' Laboratories, Inc., is being requested.

The Waters Conley pasteurizer heated milk slightly above 150° F. during the 30-minute holding period (Table 1, Figs. 2 and 3). The time involved for complete pasteurization of the milk from start was found to range from 60 to 90 minutes, depending upon the temperature and the volume of milk pasteurized. The limiting factor in the time of pasteurization seemed to be the temperature of the

Fig. 1. The Waters Conley pasteurizer filled with milk ready for pasteurization.

milk at the start of pasteurization and the amount of milk pasteurized. Regardless of the volume of milk—2, 3, or 4 quarts, or the starting temperature—the milk was held from 147° to 153° F. for 30 minutes. Convection currents kept the temperature of the milk uniform throughout the container. The pasteurizing efficiency was found to range from approximately 84 to 99 percent (Table 2), depending upon the initial bacterial quality of the milk. Phosphatase tests made on the milk during pasteurization indicated that the phosphatase was

TABLE 1—*Time required to pasteurize various quantities of milk at different starting temperatures in the Waters Conley home pasteurizer.*

Temperature of milk at start of heating (°F.)	Quantity of milk											
	2 quarts				3 quarts				4 quarts			
	Time (minutes) for		Final temperature (°F.) of		Time (minutes) for		Final temperature (°F.) of		Time (minutes) for		Final temperature (°F.) of	
	heating	holding	heating	holding	heating	holding	heating	holding	heating	holding	heating	holding
40.	29	34	153	152	37	37	146	151	56	38	147	153
50	27	34	151	153	38	36	145	154	46	39	145	150
60.	24	36	147	154	33	37	144	152	42	37	147	153
70.	22	35	153	153	29	37	142	152	40	40	145	154
80.	20	35	145	152	30	31	144	153	33	37	144	152
90	18	36	145	154	22	36	142	151	25	38	141	151
100.	14	36	149	155	18	36	148	152	24	36	147	151

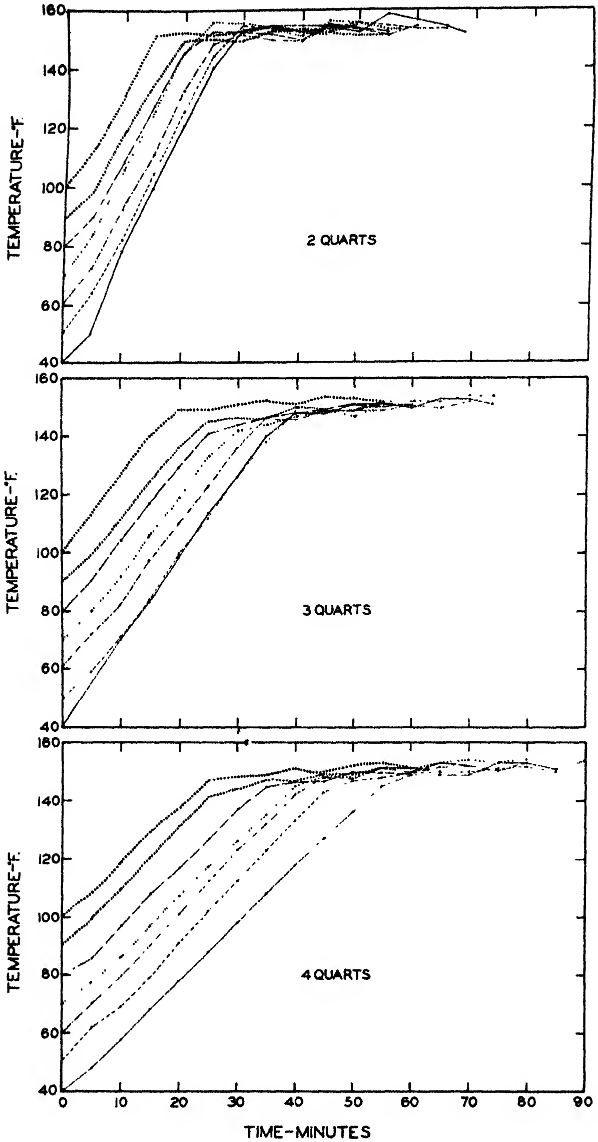

Fig. 2. The time required to pasteurize 2, 4 and 6 quarts of milk in the Waters Conley pasteurizer, when the starting temperature of the milk varied from 40 degrees to 100 degrees F.

TABLE 2—*Progressive destruction of bacteria during pasteurization of high- and low-count milk, using various home electric pasteurizers*

Time from start of heating (minutes)	Bacterial plate count in milk of trial					
	1		2		3	
	Number	Percent destroyed	Number	Percent destroyed	Number	Percent destroyed
	Waters Conley					
0	530,000	0.0	24,000	0.0	7,500	0.0
20	300,000	43.4	22,000	8.0	6,400	14.7
40	230,000	56.6	15,000	37.5	400	94.3
60	120,000	77.4	6,200	74.0	200	97.3
80	83,000	84.3	1,000	95.8	100	98.7
	SafGard					
0	240,000	0.0	1,850,000	0.0	10,300	0.0
20	180,000	25.0	1,500,000	19.0	10,000	3.0
40	70,000	70.8	190,000	89.7	7,000	33.0
60	32,000	86.7	150,000	91.9	3,500	64.0
75	19,000	91.9	130,000	93.0	1,900	81.5
	Wright					
0	50,000	0.0	13,000	0.0	63,000,000	0.0
90	1,000	98.0	700	94.6	530,000	99.1

destroyed from 10 to 20 minutes before the end of the pasteurization exposure (Table 3). Hence, there would seem to be considerable margin of safety with this pasteurizer. Likewise, coliform bacteria were destroyed considerably before the end of pasteurization. The pasteurized milk had an excellent flavor, there being no semblance of a "scorched" or "cooked" flavor. This fine flavor was retained upon 3-day storage. The creaming ability was impaired slightly.

SafGard pasteurizer

Schaenzer and Shiozawa (1) describe the SafGard (Fig. 4) pasteurizer as follows:

> A home pasteurizer electrically operated is manufactured by Guardit Manufacturing Company, 615 North Aberdeen Street, Chicago, Illinois.

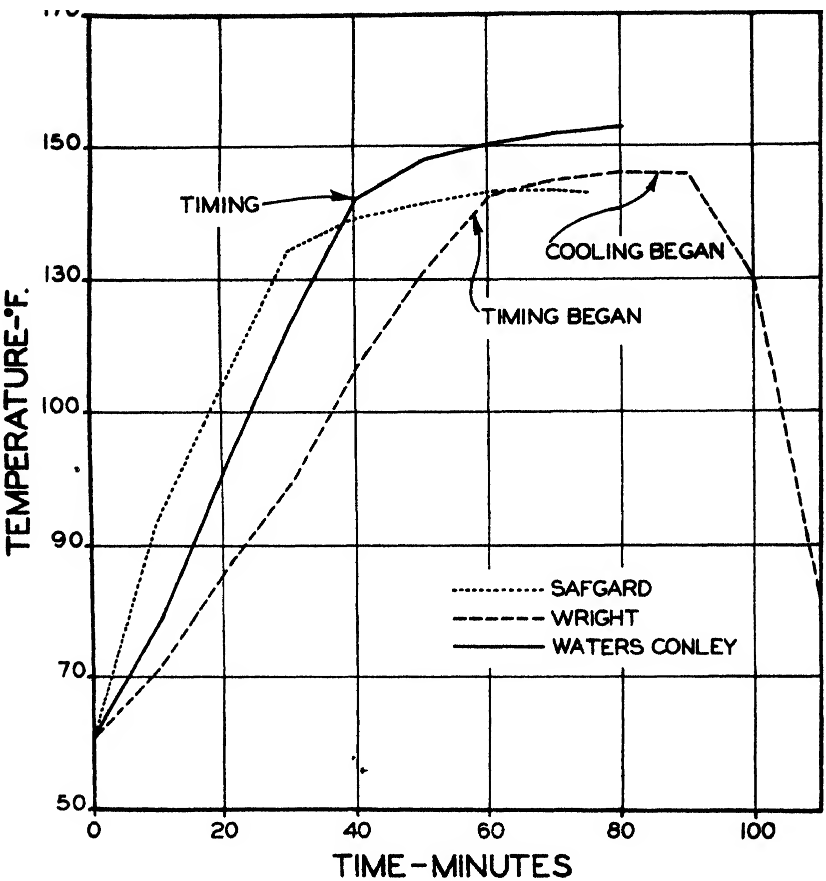

Fig. 3. Time involved and temperatures attained when pasteurizing 60 degree F. milk using the several home electric pasteurizers.

This unit stands approximately 21 inches high and has an outside diameter of about 12 inches. It consists of an outer rust-resistant metal water container, equipped with handles and coated with baked enamel, a cover with built-in stainless steel agitator, operated with a solenoid type motor, and an inner steel, tin hot dipped, two-gallon milk container. A 1250 watt, 110-120 v., a.c., 60 cycle immersion-type heater is installed in the base.

When pasteurizing milk, the water tank is filled with 9 quarts of water. The timer is set for about 30 minutes and the unit plugged into an outlet. When the water is heated to a tem-

perature of 145 to 149 F., the thermostat setting, the lower of two lights glows on the control panel. If warm water is used, less time will be required. The pail, containing the milk, is then set in the water bath. This container is held by a strap hanger, supported on rubber gaskets. The cover assembly is next put in place and the motor-agitator plugged into the front panel outlet. The time switch is set for one hour. If the milk is below 60° F., an extra 15 minutes should be allowed for heating the milk. The thermostat automatically turns the heater on and off to maintain the water and milk at the required temperature. When the upper lamp lights, it indicates the end of the pasteurization process.

It is claimed by the manufacturer that the up and down action of the agitator not only causes the milk to circulate but this action is also transmitted to the surrounding water bath, thus insuring an even temperature distribution both in the milk and the water.

If a pressure water supply is available, cold water can be circulated around the milk container by means of a hose connection. An overflow is provided. Operation of the agitator for about 20 minutes will insure still faster cooling. Or, the milk container may be removed immediately after pasteurization

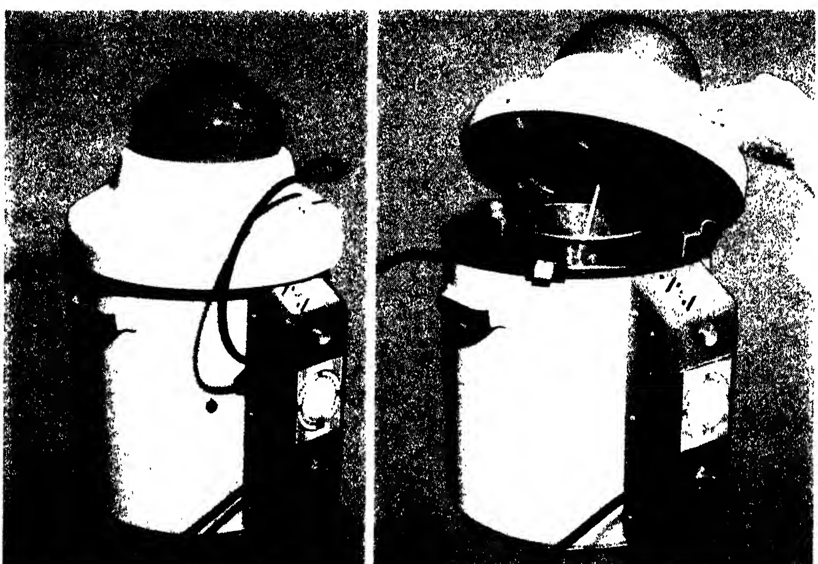

Fig. 4. The SafGard pasteurizer showing complete assembly (left), and an open view (right) as the motor agitator mounted cover is being placed in position for pasteurization.

and placed in a milk cooler for storage. Again, the agitator should be used to speed up the cooling.

The time required to pasteurize milk by the SafGard pasteurizer was found to be about 75 minutes. (Table 3 and Fig. 3.) Inasmuch as the milk was heated with hot water as a heating medium, surrounding the pail of milk, and the milk was agitated during the process, it is not surprising to note a shorter time actually involved in heating the milk to pasteurizing temperature. Pasteurizing efficiency noted ranged from approximately 82 to 92 percent, depending upon the initial bacterial quality of the milk (Table 2). The phosphatase was usually present at 60 minutes of heating (Table 3) with some exceptions (Table 4), but was not present at 70 minutes of heating (Table 2). Undoubtedly the initial temperature of the milk is the chief factor affecting the presence of phosphatase after 60 minutes of heating. Thus, milk pasteurized by this home pasteurizer would seem to be rendered safe as indicated by the phosphatase and coliform tests, when the pasteurizing process involved an extra 15-minute holding period, as recommended by the manufacturers in pasteurizing below 60° F. milk. Flavor studies made on the milk pasteurized by this pasteurizer indicated that it was of excellent quality, both at the time of pasteurization and after 72-hours storage. The creaming ability was impaired slightly. Churning was not encountered in winter milk but some free fat was noted on the pasteurized product when high test milk from cows on grass was pasteurized.

Wright, In-the-Bottle, Pasteurizer

Schaenzer and Shiozawa (1) describe this pasteurizer (Figs. 5 and 6) as follows:

> The pasteurizer, developed by H. E. Wright Company, 32 Cambridge Street, Charlestown, Massachusetts, is an in-the-bottle household unit, about 24" x 14" x 10" in size and weighs 24 pounds empty. Its capacity is 9 square quart milk bottles, or 7 round quart milk bottles or 7 quart fruit jars. In each case an extra bottle filled with water is used for immersing a thermostat which operates at 143° F. and is fastened to the cover.
>
> The outer shell of the pasteurizer is made of rust-proof metal and finished with baked enamel. The inner shell is made of either cast aluminum or copper and the lid of stainless steel. It is insulated on all sides and bottom with corrugated asbestos sheets. The 1,500 watt immersion-type heating element oper-

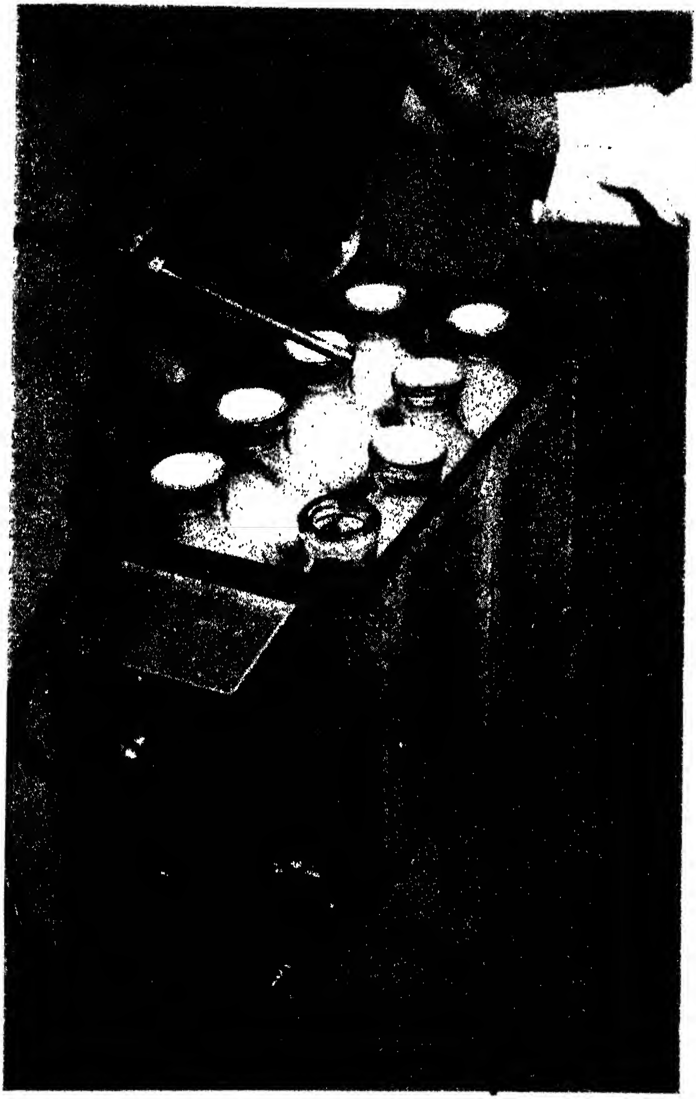

Fig. 5. The Wright in-the-bottle pasteurizer with filled bottles ready for pasteurization. The overflow pipe (not shown) is in the lower left hand corner.

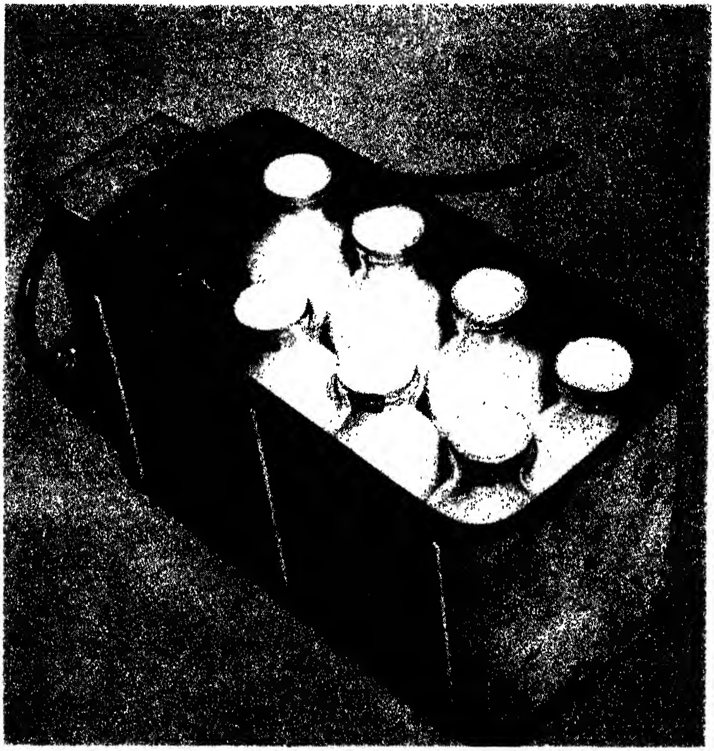

Fig. 6. Sufficient air space must be provided in the bottles for expansion. The overflow pipe should carry the water level up to or above that of the milk.

ates on 115 v., a.c., 60 cycles. A second thermostat is located in the bottom of the tank which controls the water bath at 147 to 149° F.

The unit is practically automatic in operation. When pasteurizing it is connected to the pressure water system by means of a hose. The capped bottles of milk are then placed in the tank. A little air space should be left in each bottle to allow for expansion of the milk. The cover is put on with the thermostat placed in the bottle of water. The thermostat cord is connected to the control panel. The switch is put in the "on" position and the timer is set in the "off" position. A magnetic valve opens and the water flows into the tank. The depth is controlled by an overflow pipe which can be removed for draining and cleaning the tank. Different lengths of overflow pipe are provided for various heights of bottles. After the tank is filled with water,

TABLE 3—*Progressive destruction of phosphatase and coliform organisms in milk pasteurized by the Waters Conley and SafGard pasteurizers*

Temperature to which milk was heated momentarily (°F.)	Time to reach temperature (minutes)	Pasteurization test on milk: Phosphatase	Pasteurization test on milk: Coliform*—most probable number per 100 ml.
Waters Conley			
Trial I			
47 (raw)	0	+	180,000+
61	10	+	180,000+
85	20	+	1,800+
109	30	+	1,800+
129	40	+	1,800
146	50	+	161
149	60	+	0
151	70	+	0
149	80	—	0
151	85	-	0
Trial II			
44 (raw)	0	+	220,000
60	10	+	1,610,000
78	20	+	1,610,000
98	30	+	92,000
116	40	+	180,000
134	50	+	1,610
150	60	+	0
150	70	-	0
150	80	—	0
152	90		0
Trial III			
59	0	+	0
78	10	+	22
100	20	+	0
124	30	+	0
145	40	+	0
147	50	—	0
151	60		0
153	70	—	0
151	77	-	0
SafGard			
Trial I			
48	0	+	16,100
104	10	+	9,200
128	20	+	2,200
137	30	+	220
140	40	+	0
142	50	+	0
142	60	+	0
143	70	—	0
143	80	—	0
Trial II			
60 (raw)	0	+	9,200
94	10	+	5,200
114	20	+	5,200
131	30	+	220
138	40	+	0
141	50	+	0
142	60	+	0

TABLE 3 — *Continued*

Temperature to which milk was heated momentarily (°F.)	Time to reach temperature (minutes)	Pasteurization test on milk: Phosphatase	Pasteurization test on milk: Coliform* — most probable number per 100 ml.
Trial III			
58 (raw)	0	+	920,000
108	10	+	920,000
130	20	+	2,200
138	30	+	0
141	40	+	0
142	50	+	0
143	60	+	0
143	70	−	0
143	75	−	0
Trial IV			
56 (raw)	0	+	1,610,000
104	10	+	1,800,000
123	20	+	1,800,000
134	30	+	2,200
139	40	+	0
141	50	+	0
142	60	+	0
143	70	−	0
143	75	−	0

*Brilliant-green-lactose bile medium was used.

the timer is set in the "start" position. This automatically cuts off the water flow and turns on the heater. It requires about 50 minutes to bring the temperature in the water-filled bottle to 143° F. Then the timer, which is set for a 30-minute pasteurization period, starts. It stops if the temperature in the bottle falls below 143° F. When pasteurization is completed, the magnetic valve opens and allows cold tap water to circulate around the bottles. Cooling requires about 20 minutes and the flow of water is stopped by turning the switch to the "off" position. The milk is then ready for use or storage.

The Wright in-the-bottle pasteurizer required approximately 85 minutes to pasteurize the milk, not including the cooling period (Fig. 1). With this pasteurizer the milk was heated to a maximum temperature of around 146° to 148° F. Negative phosphatase tests were secured in all bottles, regardless of the position of the bottle in the pasteurizer. Likewise, negative coliform tests were obtained. Thus, this pasteurizer would seem to render the milk perfectly safe. The pasteurization efficiency noted ranged from approximately 95 to 99 percent. Flavor examination of the milk showed the milk to be of excellent quality. The creaming ability was impaired slightly.

TABLE 4—*Comparison of the Waters Conley, SafGard and Wright pasteurizers on the same samples of milk*

Trial	Nature of milk	Name of pasteurizer	Standard plate count	Phosphatase test	Coliform test—most probable number per 100 ml.
I	Raw		50,000	+	220
	Pasteurized	Waters Conley	3,000	−	0
	Pasteurized	SafGard	1,500	+[1]	0
	Pasteurized	Wright	1,000	−	0
II	Raw		13,000	+	920
	Pasteurized	Waters Conley	300	−	0
	Pasteurized	SafGard: 60 minutes	500	−	0
		75 minutes	500	−	0
	Pasteurized	Wright	700	−	0

[1] Milk at 62°F. at beginning was held only 60 minutes

DISCUSSION

While these pasteurizers rendered the milk safe as indicated by the phosphatase and coliform tests (Tables 3 and 4), it should be pointed out that some precautions are necessary in their operation. For example, in operating the Waters Conley pasteurizer, care should be taken to see that the lid is placed tightly on the milk container during pasteurization and cooling of the milk. Milk pasteurized in this pasteurizer might well be cooled in the pasteurizing receptacle, by setting it in a pan of water, or by placing it directly in the refrigerator. When filling the container with cold milk, it would seem advisable to allow sufficient head space for expansion during pasteurization, otherwise, the pail may be so full that it will be difficult to handle without sloshing some of the milk onto the cover from where it may ooze out and flow down the outside of the pail.

Precautions should be taken in the operation of the SafGard pasteurizer to see that the milk is heated sufficiently long before being cooled. From the data obtained 60 minutes seems hardly long enough for routine heating of the milk. Seventy-five minutes seems to be preferable. The extra 15 minutes should give an ample margin of safety. Inasmuch as the milk is not protected after pasteurization, care should be exercised that the milk is not re-contaminated following pasteurization and cooling.

Attention should be paid to the water level maintained in the Wright in-the-bottle pasteurizer. The overflow pipe must be of such a height that the water level is up to the level of milk in the bottle at all times. Also, the bottles must not be filled so full that

insufficient head space for expansion during heating is not provided. Expansion of overfilled bottles during heating may cause seepage. Later, when such milk cools, it may become contaminated through the suction of the seeped milk back into the bottle. At least a full inch of air space under the cap space of the standard round milk bottle should be provided. The rate of inflow of the water under pressure should be adjusted so that when cooling is permitted automatically, the water inflow does not exceed the outflow, thus flooding the bottles of pasteurized milk.

It should be pointed out that these pasteurizers studied under laboratory conditions were new and in excellent working condition. Field studies should be made to ascertain their efficiencies and stabilities under actual extended home use. Also, operating cost studies would be of interest.

No attempt is made herein to point out the advantages and disadvantages of the different pasteurizers used in this study. The main points of interest have been (a) whether the milk were adequately pasteurized and (b) if the normal physical and taste qualities of the milk were maintained. Obviously, facilities for operating, cooling the milk, cleaning the equipment, volume of milk to be pasteurized, the length of time desired to pasteurize, costs, and so on, are factors to be considered in purchasing any pasteurizer. These are beyond the scope of these studies.

CONCLUSIONS

The Waters Conley, SafGard, and Wright electric pasteurizers pasteurize milk adequately when operated according to directions. as indicated by the total plate count and by the phosphatase and the coliform tests. The pasteurized milk had a fine flavor, there being no evidence of a cooked flavor in the milk pasteurized by any of the pasteurizers studied. Creaming was impaired to some extent, but this would seem to be of minor importance in home pasteurized milk.

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CONTINUOUS CORN VS. CORN IN ROTATION

By A. G. WEIDEMANN

SECTION OF SOIL SCIENCE

SOME OF THE advantages of growing crops in rotation have been known for many years and, no doubt, that knowledge came about originally through observation and experience. Not only are these advantages reflected in the physical conditions of the soil but also in the control of certain fungus and bacterial diseases of plants, as well as in crop yields. A considerable amount of investigational work has been done to measure the effects of these practices on the yields of crops, especially corn, grown on different soil types.

REVIEW OF LITERATURE

In Missouri, where corn was grown continuously and in rotation for 30 years, both unfertilized and manured at the rate of 6 tons per acre annually, Miller and Hudelson (2) report 30-year average yields of 20.9, 34.9, 38.5 and 47.7 bushels, respectively, from continuous corn, continuous corn manured, a four-year rotation of corn, oats, wheat and clover, and the same rotation manured. Hudelson and Helm (1), commenting on the above mentioned experiment, give the yields for the thirty-first year of the experiment as 19.6, 39.1, 52.5 and 60.1 bushels respectively for the same treatments. Smith (3), in 1942, gave the 50-year average yields from the above mentioned treatments as 18, 33, 37 and 47 bushels respectively. Although corn yields vary somewhat from year to year, largely due to weather conditions, there is a general similarity between yields, from the treatments mentioned, for one year, as a 30-year average and as a 50-year average. Smith (3) states that a good rotation is as valuable in maintaining or increasing crop yields as a six-ton annual application of manure. He also adds that a good rotation is not sufficient, but should be supplemented with manure or commercial fertilizer. Stevenson and Brown of Iowa (4) report, as a 6-year average, 40.3, 55.8, 64.3 and 66.6 bushels of corn respectively from continuous corn, a 2-year rotation of corn and oats, a 3-year rotation of corn, oats and clover, and

ARTICLE 30-12

a 2-year rotation of corn and oats with clover green manure turned under. The value of all crops grown in the 3-year rotation was much greater than the value of corn where grown continuously and somewhat greater than the value of all crops in any other rotation.

Two years of corn in succession in a rotation is not at all uncommon in the corn belt and that practice is sometimes recommended in proposed rotations. Wallace and Bressman (5), however, state that only on the very richest soils can corn be grown for more than 2 years in succession with any assurance of profit.

EXPERIMENTAL WORK

An experiment was started in 1940 on Hillsdale sandy loam soil on the Michigan State College farm at East Lansing to study the effect of different crop rotations, with and without fertilizer, on yields of crops and accumulation of humus in the soil. The experiment has not progressed far enough to enable one to determine, with any degree of accuracy, changes in the humus content of the soil due to treatments. The effect of treatments on the yields of corn, however, are sufficiently outstanding to justify a preliminary report at this time.

TABLE 1—*Yields of corn grown continuously and in rotation with and without fertilizer*

(Bushels of grain and pounds of stover)

Treatment	Product	Yields per acre								
		1940	1941	1942	1943	1944	1945	1946	Av. all years	Av. 1940, 1943, and 1946
Corn in rotation, fertilized.	Grain. . .	47.7			61.6			33.1	47.5	47.5
	Stover .	4587			4489			2605	3894	3894
Continuous corn, fertilized	Grain. . . .	51.4	35.8	59.9	35.4	17.2	31.5	14.9	35.2	33.9
	Stover . .	4160	2729	4685	4214	2619	2534	2400	3339	3591
Corn in rotation, not fertilized.	Grain. . .	29.4			39.2			19.0	29.2	29.2
	Stover .	4152			3129			2222	3168	3168
Continuous corn, not fertilized.	Grain. . . .	32.2	25.3	59.7	20.6	2.5	8.8	2.8	21.7	18.5
	Stover .	4160	2729	3947	2640	1511	2427	1538	2709	2782

Corn was grown continuously with and without fertilizer, and also grown in a rotation of corn, barley and clover, with and without fertilizer. On the fertilized plots 200 pounds per acre of 2-12-6 were drilled in the row with each planting of corn, while 400 pounds per acre of 3-12-12 were drilled with barley seeded to medium clover. The data presented in Table 1 cover a period of 7 years from 1940 to 1946 inclusive.

DISCUSSION

The data show that in the first year of the experiment the fertilized plots outyielded the unfertilized by a very substantial margin. Also the unfertilized continuous corn plot outyielded the unfertilized rotation corn plot in both grain and stover, while the continuous corn plots with fertilizer outyielded the fertilized rotation plots in grain but not in stover, indicating that any differences in the productivity of the plots at the beginning of the experiment were in favor of those that were to grow corn continuously. These results may be contrasted with the yields at the end of the 7-year period. While there is a fluctuation in yield from year to year, mostly due to weather conditions, the trend for continuous corn is definitely downward. The yield of corn grain from the unfertilized continuous corn plot at the end of a 7-year period is almost nil. On the other hand the plots growing corn in rotation have maintained a fairly level state of productivity as indicated by the fact that the average yields for the three years (1940, 1943 and 1946) when all plots grew corn is about the same as the original yields. This may be seen by comparing the yields for 1940 with the averages given in the last column of figures in the table.

At first thought it might seem that the yields presented in Table 1 are not in accord with the results of numerous other experiments in the fertilization of corn which indicate that the value of applications of fertilizer directly for corn is questionable. A careful analysis of the situation, however, reveals that such is not necessarily the case.

In general the fluctuations in corn yields from year to year secured in this experiment were very similar to those of other experiments in the vicinity. In 1942 in all fertilized rotations in a nearby experiment, in which fertilizer was applied for corn and wheat, corn considerably out yielded that in adjacent rotations that had not been fertilized for some time. Some increases were as great as 28 bushels per acre. On the other hand, in the same experiment in 1934 and 1936 nearly

Fig. 1. Corn yields for 1946 from two rows 70 feet long, with corresponding husked corn below each shock graded into good and poor ears from left to right respectively. Shocks from left to right: corn grown in rotation and fertilized (33.1 bu.), corn grown continuously and fertilized (14.9 bu.), corn grown in rotation without fertilizer (19.0 bu.) and corn grown continuously without fertilizer (2.8 bu.). (Yields stated in bushels per acre.)

all fertilized rotations yielded less corn than the unfertilized rotation. There are all degrees of benefit from fertilization between these two extremes. Hence, we must admit that direct application of fertilizer to corn is beneficial in only occasional years. As a rule, the more favorable the weather conditions for corn production the greater will be the yields from all treatments, and the greater also will be the increases due to fertilizer applications. As a result of these fluctuations in benefits to corn from direct applications of fertilizer it has been found that the average benefit over a period of years, under Michigan conditions, is not very great, especially if that period includes a few very unfavorable seasons. Consequently, the Soil Science Section has been in favor of maintaining a high state of soil fertility by fertilizing the rotation judiciously and not applying fertilizer directly to the corn crop, as this often results in a larger yield of stover and a depression in grain yield.

In this experiment we cannot say that the plots which received no fertilizer have been judiciously fertilized in the rotation—hence, the gradual decrease in yield as the experiment progresses. Corn grown continuously and fertilized is not grown in rotation, and it cannot be said that this plot was fertilized in the rotation, yet the annual application of fertilizer to this plot should tend to maintain a higher state of productivity and the yield of corn from this plot should be higher than from one that has not been fertilized at all for 8 years.

The last few years have been comparatively unfavorable for growing corn. While there was an abundance of moisture in 1945 the early part of the season was so wet that it was impossible to get corn planted early enough, and a little later it was so wet and cold that corn could not grow. As a result the crop did not mature in the fall before frosts came. In 1946 moisture was so limited throughout the season that corn could not grow well. With a more favorable season such as occurred in 1942 yields for continuous corn may be better, but it seems likely that the contrast between yields from corn in rotation and corn grown continuously will become greater as the experiment progresses as will also that between yields of corn fertilized annually and corn not fertilized at all. Not only is the yield from continuous corn less than from corn in rotation but the quality of grain is much poorer. Figure 1 is a graphic illustration of the yields and quality of corn from the various treatments for 1946. This illustration shows that the fertilized rotation plot is the only one that produced more

good, marketable corn than poor, immature corn. The unfertilized plot that grew corn continuously produced only one ear of good, marketable corn on 140 feet of row.

The results of this work add further proof to the already well established fact that corn cannot be profitably grown more than twice in succession on the best corn belt soils, and not more than once in succession on the lighter types of soil.

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RENOVATION STUDIES ON STANDS OF COMMON MILKWEED (*Asclepias Syriaca* L.) IN NORTHERN MICHIGAN

By C. M. HARRISON, JAMES TYSON *and* B. B. ROBINSON*

SECTIONS OF FARM CROPS AND SOIL SCIENCE

THE USE of floss from the pods of common milkweed as a possible substitute for kapok in life-saving equipment led to an intensive pod collection program in Michigan during 1942, 1943 and 1944. In Michigan, the collection program centered in the northwestern part of the lower peninsula and collections were largely made from volunteer stands in old pastures, cut-over areas and to some extent on land in cultivated crops.

Owing to the differences in yield of pods from these volunteer stands under a wide variety of soil and cultural conditions, renovation was suggested as a means of increasing the yield of the existing stands. As a result, renovation studies were started in the fall of 1942 and completed in the fall of 1944. Of primary importance, in the renovation trials, were the possibilities of increasing the yield of pods from the volunteer stands by various cultural practices and fertilizer applications and the cost of securing the additional yield.

Consequently, two renovation-fertilizer tests were set up in November 1942 on milkweed-infested grassland and an additional renovation test on cultivated land in Emmet County near Petoskey, Michigan. The results of the various trials are summarized in Table 1.

A study of Table 1 shows that the average yields of pods on Kentucky bluegrass and quack grass areas were increased over the check when dragged once with a springtooth harrow either in November or May, with the November dragging resulting in the larger increase per acre. In one trial, spring plowing, without further working or fertilizing of the land, resulted in an increase of over 250 pounds of pods per acre over the average of two check areas. Applications of fertilizer,

*Joint contribution from U. S. Department of Agriculture and Michigan Agricultural Experiment Station. Professor and Associate Professor, Michigan State College and Senior Agronomist, Bureau Plant Industry, Soils and Agricultural Engineering, A.R.A., U.S.D.A., respectively.

ARTICLE 30-13

TABLE 1—*Summary of data from milkweed renovation trials in Emmet Co. 1942-43. Yield of pods, green weight, on an acre basis harvested in the fall of 1943.*

Milkweed stand and yield variables	Spring-tooth dragged once Nov. 1942	Check	Dragged once May 1943	Plowed May 1943		No tillage		Lime and fertilizer	Check
				No fertilizer	200 pounds per acre 0-20-20	200 pounds per acre 0-20-20	400 pounds hydrated lime		
KENTUCKY BLUEGRASS SOD:									
Pounds green pods per acre	135	65	90	388	371	237	224	253	198
Number pods per acre	5,846	2,815	3,897	13,968	13,356	10,262	9,699	10,955	8,573
QUACKGRASS SOD:									
Pounds green pods per acre	84	16.4	44.8	....	....	29.6	32.0	46.8	42.0
Number pods per acre	4,160	975	1,430	....	....	1,820	1,950	2,860	2,535
Number stems per acre	13,504	13,504	13,504	....	....	9,583	15,682	15,246	12,632
Ratio—pods to stems	.31	.07	.11	....	....	.19	.12	.19	20
BROMEGRASS SEED IN 1942:									
Pounds green pods per acre	72	201.2	154.3	....	....	....	....	....	....
Number pods per acre	3,427	9,577	7,345	....	....	....	....	....	....
Number stems per acre	11,326	14,593	13,068	....	....	....	....	....	....
Ratio—pods to stems	.30	.66	.56	....	....	....	....	....	....
AVERAGES:									
Pounds green pods per acre	97	94.2	99.7	....	....	133.3	128.0	150	120
Number pods per acre	10,259	10,304	10,157	....	....	9,922	12,690	13,100	10,602

lime or a combination of both produced only small increases when compared to the check. A quack grass sod seemed to hinder the growth of milkweed to a much greater extent than did a Kentucky bluegrass sod. None of the renovation or fertilizer treatments paid for the added expense of treatment in increased yield of pods.

The results from the bromegrass field were unsatisfactory and inconsistent, apparently due to variations in soil and the original stand of milkweed.

Because of limited number of trials and the variations in the results of the 1942-43 tests, arrangements were made to conduct four additional tests in the Emmet County area on a more extensive scale in the 1943-44 seasons. Rains followed by heavy snows prevented carrying out the November treatments planned by way of cultural practices and the experiments were modified to increase the number of cultural operations in the spring.

Table 2 shows the results of one such test on Kalkaska sandy loam in which fertilizers were applied across five different treatment strips. The area included in plots 6 to 15 inclusive had been cropped last

TABLE 2—*Yield of milkweed pods in pounds per plot, green weight, from fertilizer and renovation test in 1944. Sub-plots 22.5 x 40 feet in area.*

Plot No.	Fertilizer treatment*	Cultural treatments**					Totals
		Corn A	Check B	Dragged 2 x C	Check D	Dragged 4 x E	
15	0-20-20	43.2	17.6	11.9	39.4	41 7	153.8
14	3-12-12	20.1	23.2	34.2	10.3	48 4	136 2
13	0-0-0	21.4	13.1	37.5	21.4	58 0	151.4
12	20-0-0	7.0	24.3	36.5	18.5	38.0	124.3
11	Manure	12.5	14.0	30.5	19 5	39.0	115 5
10	0-20-20	16.5	22.0	27.0	15.0	28.5	109.0
9	3-12-12	12.0	25.0	19.1	11.0	13.8	80.9
8	0-0-0	14.5	14.9	30.1	9.0	13.2	81.7
7	20-0-0	22.4	14.6	44.6	20.3	37.4	139.3
6	Manure	20.6	13.4	36.9	19.2	30.2	120.3
5	0-20-20	....	....	13.2	6.0	9.4	28.6
4	3-12-12	....	....	23.4	3.5	4.0	30 9
3	0-0-0	....	....	15.4	11.5	7.5	34.4
2	20-0-0	....	....	29.5	15.8	6.2	51.5
1	Manure	....	....	12.0	6.0	9.2	27 2
Plot totals (6–15)		190.2	182.1	308.3	183.6	348.2	
Totals (1–5)		....	....	93.5	42.8	36 3	

*Fertilizer treatment—200 pounds per acre, manure at 10 tons per acre.
**Cultivation treatments— A—Land prepared, planted to corn and cultivated up to July
B—No treatment—check.
C—Dragged twice in spring (springtooth harrow)
D—No treatment—check.
E—Dragged four times in spring (springtooth harrow).

TABLE 3—*Yield of harvested milkweed pods in pounds per plot, green weight, from fertilizer and renovation test in 1944. Sub-plots 21 x 42 feet.*

Plot No	Fertilizer treatment*	Cultural treatments**					Totals
		Dragged 4 x A	Check B	Dragged 2 x C	Check D	Dragged 4 x corn E	
8	0-20-20	14.8	17.3	11.0	8.3	3.8	55.2
7	20-0-0	24.5	20.4	25.6	9.6	6.6	86.7
6	Check	21.0	18.0	24.8	14.4	4.8	83.0
5	Manure	5.7	18.0	16.8	15.0	8.0	63.5
4	0-20-20	4.2	12.3	24.0	10.0	6.6	57.1
3	20-0-0	10.5	13.8	24.8	17.4	12.0	78.5
2	Check	11.5	10.5	28.0	24.0	12.6	86.6
1	Manure	15.5	28.2	38.8	24.0	9.5	116.0
	Totals	107.7	138.5	193.8	122.7	63.9	

*Fertilizer treatment—All fertilizers applied at 200 pounds, manure at 10 tons per acre.

**Cultural treatments A—Springtooth dragged four times in spring at weekly intervals.
B—Check—no treatment.
C—Springtooth dragged in spring twice at weekly intervals.
D—Check—no treatment.
E—Springtooth dragged four times at weekly intervals planted to corn and cultivated up to July 1st

in 1942, that of the area included in plots 1-5 in 1943. The two crop areas were adjacent and had laid idle after the crop years of 1942 and 1943 respectively. Both areas had an excellent crop of volunteer milkweed plants at the time the tests were laid out.

A study of Table 2 shows little concrete evidence in favor of any fertilizer treatment whereas the dragging treatments approximately doubled the yield over the check areas. The results indicate that the control of competing vegetation by dragging in the spring had a favorable effect on the yield of pods. In this test, the planting and cultivation of corn in a milkweed-infested area did little to increase the yield of pods over that of the check area.

A similar test was laid out on a field which had been in corn the year previous, but the soil type was Emmet sandy loam. The results of this test are shown in Table 3.

The results, tabulated in Table 3, vary somewhat from similar tests tabulated in Table 2. In Table 3, the highest yield of pods was secured from dragging twice in the spring as contrasted to the highest yield in Table 2 from dragging four times. Likewise, the yield from the cultural treatment where corn was planted varied considerably in the two tests, being equal to the check in one case and only half of the check in the other. In general, the yield on the Emmet soil type test was approximately half of that from the

Kalkaska soil type. This difference may have been due largely to the difference in fertility and moisture rather than a difference in soil type. The test, reported in Table 3, showed approximately the same effect in respect to fertilizers as did that reported in Table 2. Likewise, it shows that control of plant competition is more important than fertilizers. The degree of control by dragging or cultivation varied somewhat in the two tests, the extra dragging being beneficial in one test and detrimental in another to the yield of milkweed pods.

In addition to the two tests on recently cultivated crop land, two tests were conducted on land which had been in quack and bluegrass for a considerable period of time. As the two tests were similar as to soil type, grass cover and milkweed infestation, the results were averaged and tabulated in Table 4.

A study of Table 4 shows that any degree of cultivation tried in the test resulted in practically doubling the yield of pods over that of the check areas. The amount of dragging after spring plowing had little effect on the yield of pods whereas the "quack-hogging" at six times resulted in some damage to the growing milkweed.

DISCUSSION

The foregoing tables show that it is possible to increase the yield of pods of common milkweed by certain renovation practices. In general, it appears that fertilizers do not aid materially in increasing the yield but that any cultural practice, which tends to discourage

TABLE 4—*Average yield of milkweed pods per plot, green weight, from two renovation tests conducted in Emmet County, Michigan in 1944. Plots 20 x 436 feet in area.*

Plot No	Treatment*	Average weight of pods per plot
1	Check	36.2
2	Plow and drag 2 x	76.3
3	Plow and drag 3 x	67.8
4	Plow and drag 4 x	71.0
5	Check	67.8
6	Quack-hog 2 x	57.4
7	Quack-hog 4 x	78.4
8	Quack-hog 6 x	74.6
9	Check	29.3

*All treatments in the spring. Dragging was done with a springtooth drag and "Quack-hogging" was done with a wheeled, field cultivator.

grass or weed competition with the milkweed, resulted in higher yields.

Because milkweed plants are slow to start growth in the spring and the new growth starts from one to several inches underground, it is possible to cultivate, drag or even plow in early spring without much damage to the milkweed stand. Cultural practices which extend over into the period of initial growth of the new shoots of milkweed will probably affect the yield in two ways; (1) by injuring the new shoots as they are emerging or (2) by delaying the crop so that frost will kill the plants while the pods are immature.

SUMMARY

1. Several renovation and fertilizer tests were run in Emmet County, Michigan from 1942 to 1944 on common milkweed to determine the best methods of increasing pod yields in volunteer stands.

2. Fertilizer and lime applications had little effect in raising the yield of pods over that of the untreated areas.

3. Spring-tooth dragging, "Quack-hogging," plowing or combinations of these three practices resulted in increased yields of pods provided the practice was carried on in early spring before the milkweed began growth.

4. Working an area, planting to corn and cultivating up to July 1 resulted in less yield of pods than where the cultural work was completed at an earlier date.

5. Competition from grass and weeds with the milkweed seemed to be the most important factor in lowering pod yields from volunteer stands.

THE USE OF NEW-TYPE ATOMIZERS IN THE PROPAGATION GREENHOUSE

By F. L. O'ROURKE and J. E. MOULTON

SECTION OF HORTICULTURE

THE VALUE of humidification in the greenhouse as an aid to the rooting of cuttings is rather generally accepted, and several systems have been described during the past few years (2, 3). These may be roughly classified as: (1) Mechanical centrifugal atomizers powered by electric motors, (2) compressed air systems operating by a column of compressed air passing over water not under pressure, and (3) water under pressure forced through small apertures and broken into mist by baffles.

A fourth system not previously reported is that of using both air and water under low pressure, which is practicable only when using a special type of nozzle such as that recently described by Hamner and Tukey (1). These brass nozzles, each 1 11/16 inches long, ⅞ inch wide and 1/34 inch deep have separate openings for the entry

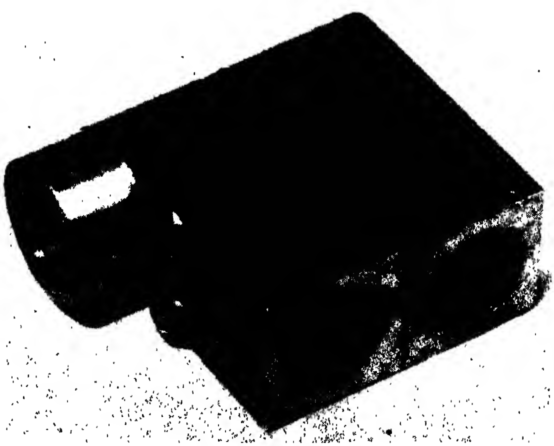

Fig. 1. Atomizing nozzle, side view.

ARTICLE 30-14

of water and of air. The compressed air blows over the water in such a way as to force it out as finely divided mist through three holes on the opposite side of the nozzle. As compared with other types of nozzles, these atomizers have given very little trouble in respect to clogging. The pattern for these nozzles was furnished by the Shell Oil Company of New York. The nozzles may be obtained from Leiman Brothers, 156 Christie Street, Newark, New Jersey.

Two one-half inch pipes, 10 feet long, in a parallel arrangement were connected respectively to a compressed air outlet and a water tap. Three nozzles were placed at equal distances on this line, approximately 3⅓ feet apart. The line was mounted lengthwise just under the ridgepole of the sash greenhouse. The atomizers may be operated with air pressures of 5 pounds or more. The water pressure is not important. The water line may be attached to any standard tap. The amount of water atomized is controlled by a valve so that any quantity from one to twelve gallons per nozzle per hour is delivered. The hotter and drier the day the greater the amount of water required both to maintain a high degree of relative humidity and to create a film of moisture on the foliage of the softwood cuttings and thus cool the leaf tissue and reduce water loss by transpiration.

With the use of this humidification system, even very tender softwood cuttings in sand and vermiculite remain healthy and turgid even in hot weather. As an experiment, some cuttings were not

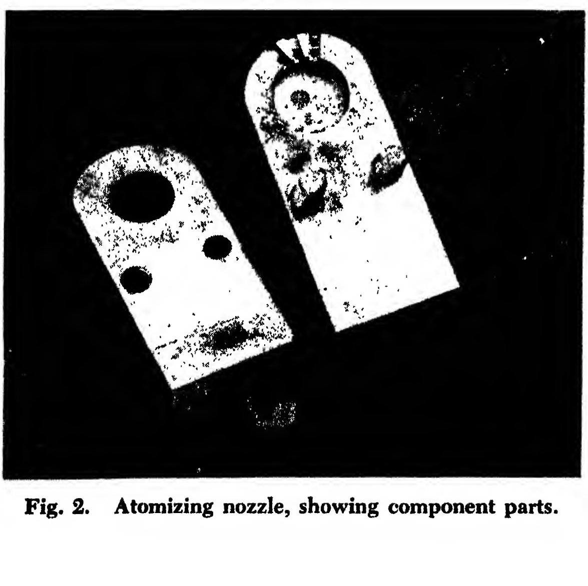

Fig. 2. Atomizing nozzle, showing component parts.

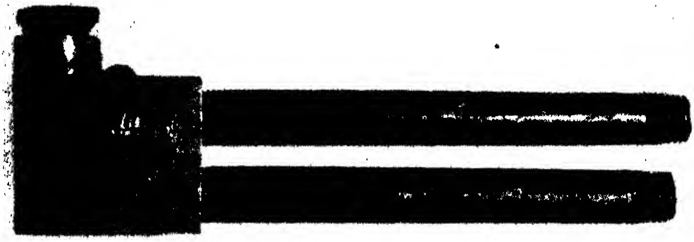

Fig. 3. Atomizing nozzle, assembled.

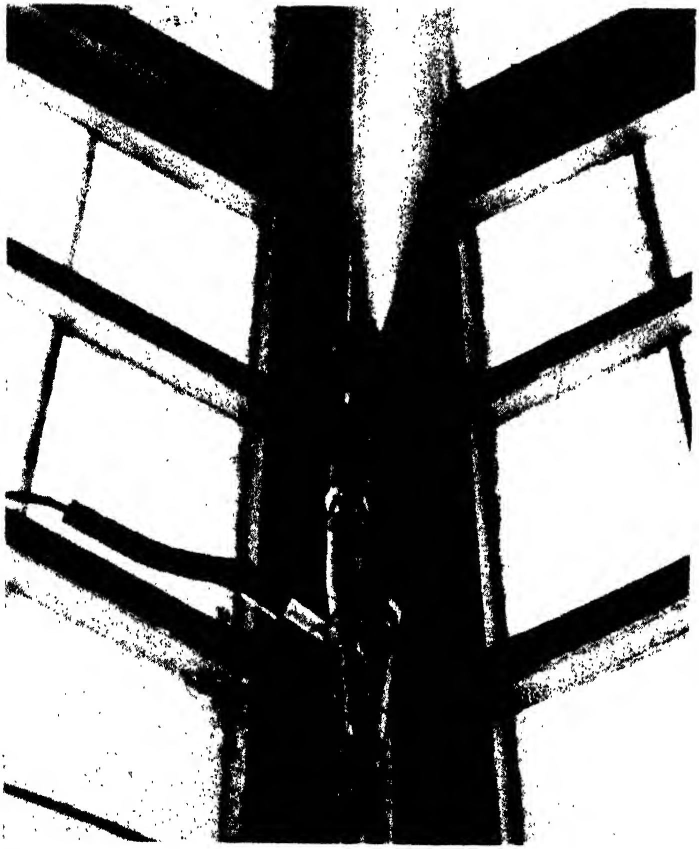

Fig. 4. Atomizing nozzle, installed in greenhouse showing mist spray.

inserted but left lying on top of the media for 6 weeks in June and July and still remained fresh and green. During all of this work, the sash-covered greenhouse was kept shaded with a water paint compound and precautions were taken to prevent the escape of moisture-laden air. Even the single door to a connecting greenhouse was kept closed at all times.

This system of atomization was constructed primarily to attain the proper atmospheric conditions in which to test several size grades of vermiculite, perlite, and sand as rooting media.

Tender softwood cuttings of *Ligustrum, Lonicera, Syringa, Chaenomeles, Euphorbia, Dianthus, Philadelphus, Deutzia, Vinca, Rosa, Spiraea, Cotoneaster, Viburnum, Cornus, Euonymus,* and *Teucrium* have been placed in the various media and none have been lost from any cause. As has previously been pointed out by Stoutemyer and O'Rourke (3), insects and pathogenic fungi are absent in a humidified atmosphere and the saturated air prevents loss by desiccation. Survival has thus been 100 percent, and rooting has accrued according to the aptitude of the plant species.

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JOURNAL ARTICLE ABSTRACTS

The Conjoint Effects of Varied Intakes of Thiamine and Vitamin A on Rats

DYE, MARIE, PORTER, T., AND KELLY, E.

Jour Nutrition. 33 (4): 459-467. 1947. [Journal Article 747 (n. s.) from the Michigan Agricultural Experiment Station]

The effect of thiamine on the utilization of vitamin A was studied by means of food intake, weight change, length of rat, and number of foci of keratinized epithelial tissues called "abscesses" in animals depleted of vitamin A.

The daily addition of 6, or 9 mcg. of thiamine to the diet, whether or not vitamin A was present, significantly increased food intakes and favorably affected weight changes in all groups of animals. On the other hand, the daily addition of ½, 1½, or 3 I. U. of vitamin A, in the absence of thiamine, did not produce significant changes in food intakes or weight losses in animals eating *ad libitum* of a basal vitamin A and thiamine free diet. In groups of animals on iso-caloric intakes, however, food intakes were somewhat lower and weight losses greater when ½ or 3 I.U. of vitamin A were given, than when neither vitamin A nor thiamine were present in the food. Vitamin A functioned as an essential factor in weight increases in the presence of thiamine.

For all groups of animals, "abscesses" were highest in number when no vitamin A was present in the diet.

Nutritive Value of Fish from Michigan Water. I. Nicotinic Acid of Lake Herring, Carp, Common Sucker and Burbot

KLOCKE, J. R., PORTER, T., TACK, P. I., LEFFLER, E., HENRY, N. S., AND NITCHALS, R.

Food Research. 11 (2): 179-186. 1946. [Journal Article 749 (n. s.) from the Michigan Agricultural Experiment Station]

Lake herring from Saginaw Bay had an average of 55, 31 and 23 mg. of nicotinic acid per gram of tissue in November 1943, and June and November of 1944, respectively. It is assumed that seasonal and environmental conditions were responsible for the differences. Nicotinic acid content of common suckers, carp and burbot was substantially lower. Only small losses in nicotinic acid were associated with freezing and storage for three months. Only small losses were occasioned by baking either the fresh or frozen fish. Smoked fish retained two-thirds of the nicotinic acid present in the fresh product. Nicotinic acid content of lake herring is comparable with that of lean meat; that of carp, burbot and common suckers is somewhat lower.

A Study of Yeast Growth-promoting Substances in White Sugar

HALL, H. H., PAINE, H. S., AND FABIAN, F. W.

Food Research. 12: 99-110. 1947. [Journal Article 756 (n. s.) from the Michigan Agricultural Experiment Station]

The white sucrose sugars, beet and cane, are perhaps the nearest approach to chemically pure substances that are included in the daily diet. However, the presence of considerable quantities of microbial growth-promoting substances would make such sugars undesirable for use in making beverages, fountain sirups, flavoring extracts and sweetened condensed milk because these products are subject to spoilage by yeasts. This study was made to correlate the relative amount of growth-promoting substances with the amount of impurities as determined by chemical analysis of beet sugar manufactured by domestic factories. It was also desired to identify the growth-promoting substances and to study the possibility of eliminating them during the manufacture of sugar.

A study of a large number of samples of beet and cane sugar over a 12-year period showed that varying amounts of substances are present in different sugars. A substance identified as biotin was found to be present in amounts from 0.025 to 0.445 micromillogram per gram of sugar. Although there is no exact correlation of the amount of growth-promoting substances with known impurities of the sugar, there is a correlation of average yeast inoculation-multiple values with average ash values. The growth-promoting substances, like most other non-sugar impurities, are located at or near the surface of sugar crystals and can be effectively diminished by controlled quantities of additional wash water while the massecuites are being centrifuged.

Some Cooking Qualities of Homogenized Milk. II. White Sauces

TOWSON, ALICE M., AND TROUT, G. M.

Food Research. 11 (3): 261-273. 1946. [Journal Article 764 (n. s.) from the Michigan Agricultural Experiment Station]

White sauces were used to study the effect of homogenization on the cooking properties of milk. Sauces made with homogenized milk showed a separation of fat in contrast with those made with unhomogenized milk which appeared smooth. As the amount of added fat was increased, the size of the fat droplets and apparent amount of separation became greater.

Increased amounts of salt caused the formation of larger fat droplets. The fat droplets were not so large when salt was added at the end of the cooking period.

Increased pressure of homogenization increased the size and apparent separation of the fat globules. The viscosity of the sauces became increasingly greater as the homogenization pressure used in preparation of the milk was increased.

Beating sauces made with homogenized milk with a rotary beater produced a product smoother and superior in flavor to those made with unhomogenized milk.

A Comparison of Various Modifications of the Babcock Test for the Testing of Homogenized Milk

TROUT, G. M., AND LUCAS, P. S.

Jour. Dairy Sci. 28 (12): 901-919. 1945. [Journal Article 769 (n. s.) from the Michigan Agricultural Experiment Station]

Twelve modifications of the Babcock test for homogenized milk were studied to determine their accuracy and to ascertain which methods were most effective in eliminating the plugs of curdy or charred material at the base of the fat column.

Five series each of lower-fat and higher-fat homogenized milk were tested by each of 10 modified methods as well as by the Mojonnier and by the regular Babcock method.

No one test was found consistently to eliminate completely the foreign material at the base of the fat column of tests on homogenized milk, although some tests reduced the amount of this material to a negligible quantity.

The modified methods, yielding results both on lower-fat and on higher-fat homogenized milk closer to those of the Mojonnier and to those of the regular Babcock test on nonhomogenized milk, had in common (a) the use of the approximate or full amount of normal strength acid required of the Babcock test; (b)the addition of the acid in at least three portions, and (c) the remixing of the acid-serum-water mixture after centrifuging and following the addition of water.

Clear, char-free fat columns were obtained by the addition of a water-alcohol mixture (1.4 to 1) to the test, as suggested by Brueckner, instead of the final addition of water.

Apparently in making a good Babcock fat test of homogenized milk, the reaction of the sulfuric acid on the proteins of the milk, particularly on that absorbed to the fat globules, must be prolonged and be as vigorous as possible without engendering sufficient heat to char the sample.

Sulfathalidine in the Treatment of, Enteric Infections of Small Animals

HEDEMAN, L. P.

Jour. Amer. Vet. Med. Assn. 108 (827): 89-91. 1946. [Journal Article 771 (n. s.) from the Michigan Agricultural Experiment Station]

Ten cases of canine enteritis responded in from 1 to 5 days to sulfathalidine therapy. Sulfathalidine was administered in doses of approximately 1 grain or more per pound of body weight daily. The drug did not cure a case of coccidiosis, but the diarrhea disappeared upon 3 days' therapy. Four cases of feline enteritis responded in from 1 to 7 days of sulfathalidine therapy.

Processed Green Beans

PORTER, T., WHARTON, M. A., BENNETT, B. B., BREWER, W. D., AND KELLEY, A. L.

Jour. Am. Diet. Assoc. 22 (12): 1084-1087. 1946. [Journal Article 776 (n. s.) from the Michigan Agricultural Experiment Station]

Ascorbic acid content of green beans was substantially reduced by all methods of processing. After blanching and frozen storage for 6 months it was half the original amount; after blanching, canning and storage for 6 months it was only a fourth the original amount; after blanching, drying and storage for 6 months none remained. Carotene content was affected but little by any of the three processing methods. Frozen beans were the most palatable. There were no significant differences between the palatability scores of the canned and dried beans.

An Electrophoretic Analysis of Changes Produced in Blood Serum and Plasma Proteins by Heat in the Presence of Sugars

HARDT, C. R., HUDDLESON, I. F., AND BALL, C. D.

Jour. Biol. Chem. 163: 211-220. 1946. [Journal Article 777 (n. s.) from the Michigan Agricultural Experiment Station]

d-Glucose inhibited the formation of the C component when bovine plasma was heated under conditions that caused its formation in the absence of d-glucose. d-Galactose, l-arabinose, sucrose, d-fructose, lactose, d-mannitol, and d-xylose all showed some degree of inhibiting action against the C component formation in heated bovine serum. Ageing in the presence of d-glucose did not alter the electrophoretic patterns of bovine plasma. Studies on bovine plasma fractions gave further evidence of the inhibiting action of d-glucose against C component formation but did not explain the mechanism of its formation. The C component was formed by heating an albumin-α-globulin fraction of bovine plasma.

Materials for Removing Taste Effects in Organoleptic Tests

BATEN, W. D.

Jour. Home Economics. 39 (1): 30-32. 1947. [Journal Article 778 (n. s.) from the Michigan Agricultural Experiment Station]

This article presents the results of experiments carried out with 24 mature and experienced judges for determining which of six materials best removes the effects of the last sample tasted. The judges were served salted tomato juice and sweetened apple juice and were requested to taste the juice by taking a large sip and to determine which of the following materials was best for eliminating the effects of the juice just tasted: water, crackers and water, cookies and water, carrots and water, a slice of an apple and water, and bread and water. Each taster was asked to use each of the test substances between the samples. Most of the judges made at least two trials with each material before recording the final score. Scores were made by listing in ascending order the rank of each for removing the taste of the last sample. The best material received a rank of 1. An analysis of variance showed that crackers and water received on the average the lowest rank, water received the highest rank average and bread and water received the next to the highest average. A slice of an apple and water proved to be very good for removing the effect of the salted tomato juice. Carrots and water were effective for removing the effects of the sweet apple juice. These experiments clearly indicated the superiority of crackers and water for eliminating the lingering effects of the two juices.

Report on Carotene in Plant Tissue

BENNE, E. J., ROSE, DOROTHY I., SATCHELL, A. JOYCE, AND DENNISTON, ELVA L.

Jour. Assoc. Official Agr. Chemists. 28: 793. 1945. [Journal Article 781 (n. s.) from the Michigan Agricultural Experiment Station]

This article reviews the recent publications dealing with chemical methods for determining carotene in plant tissues and makes recommendations for certain ones to be included in the Plant Chapter of the 1945 Edition of Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists. The details of the recommended procedures are not given in the article since they were published almost immediately in the Book of Methods.

Report on Iron in Plants

BENNE, E. J., AND SATCHELL, A. JOYCE

Jour. Assoc. Official Agr. Chemists. 28: 796. 1945. [Journal Article 782 (n. s.) from the Michigan Agricultural Experiment Station]

This article reports the progress which the Associate Referee and his associates had made in studying methods for determining iron in plant tissue and makes recommendations concerning such methods to be included in the Plant Chapter of the 1945 Edition of Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists. The details of the recommended procedures are not given in the article since they were published almost immediately in the Book of Methods.

Stamen Morphology in Flowers of the Muskmelon

MCLEAN, D. M.

Jour. Agr. Res. 74 (2): 49-54. 1947. [Journal Article 784 (n. s.) from the Michigan Agricultural Experiment Station]

Data are presented which indicate that, though most present-day muskmelon varieties have a trimerous androecium, this species was originally pentamerous. It is suggested that this condition probably characterized related Cucurbitaceae.

Treatment of Muck and Manure with 2,4-Dichlorophenoxyacetic Acid to Inhibit Germination of Weed Seeds

HAMNER, C. L., MOULTON, J. E., AND TUKEY, H. B.

Science. 103: 476-477. 1946. [Journal Article 787 (n. s.) from the Michigan Agricultural Experiment Station]

Greenhouse experiments in which 0.1 gram of 2,4-dichlorophenoxyacetic acid were applied to 1 square foot of muck soil killed all weed seeds present; applications of 0.01 gram inhibited germination of most of them. Four weeks after treatment, bean and pea seeds planted in the soil germinated normally.

Most seeds in manure treated with 10 p.p.m. of 2,4-dichlorophenoxyacetic acid were destroyed.

Artificially Induced Case of Pyelonephritis in a Bovine

FEENSTRA, E. S., CLARK, C. F., AND THORP, F.

M.S.C. Veterinarian. 5: 147-150. 1946. [Journal Article 790 (n. s.) from the Michigan Agricultural Experiment Station]

A suspension of *Corynebacterium renale* from a cow with a typical case of pyelonephritis was injected intraurethrally into the bladder of a dairy type steer about one year old under chloral hydrate anesthesia. The course of the resulting disease and the symptoms which developed in this animal were typical of field cases of cystitis and pyelonephritis, as were the results of the blood and urine analyses, the bacteriological examination, and gross and microscopic pathological examination at necropsy 9 months after inoculation.

The Isolation of Diphtheroids from Apparently Normal Cows

FEENSTRA, E. S., THORP, F., AND CLARK, C. F.

N. Amer. Vet. 27: 288-289. 1946. [Journal Article 791 (n. s.) from the Michigan Agricultural Experiment Station]

Urine samples and vaginal swabs from 13 dairy cows, most of which had been stabled near cows that had been found to have pyelonephritis, were examined bacteriologically. Eight of the cows were found to be carrying organisms related to *Corynebacterium renale*, the causative agent in specific infectious pyelonephritis.

Bacteriopathology of Infectious Bovine Pyelonephritis

FEENSTRA, E. S., AND THORP, F.

Amer. Jour. Vet. Res. 7: 432-436. 1946. [Journal Article 792 (n. s.) from the Michigan Agricultural Experiment Station]

The location of *Corynebacterium renale*, the causative agent of specific infectious bovine pyelonephritis, in relation to the resulting lesion was studied by means of sections of bladder, ureter and kidney from cows with pyelonephritis. These sections were stained by the Gram-Weigert method for staining bacteria in sections.

The location of the bacteria varied in different cases. In the milder cases, the microorganisms were present seemingly only in the cellular debris of the kidney calyces, the ureter, and bladder mucosa. In the more severe cases, the microorganisms also may be found in foci scattered throughout the kidney. Bacteria may be found in the tubules and necrotic tubular epithelium. In the characteristic lesion, the diphtheroids were in cellular debris which was flanked by a zone of necrosis and, outside of that, a zone showing chronic inflammatory changes.

Sporadic Diseases of Sheep. I.

THORP, F., AND COLE, C. L.

M.S.C. Veterinarian. 5: 141-143. 1945. [Journal Article 793 (n. s.) from the Michigan Agricultural Experiment Station]

Maggot infestations (blow fly) occur during the warm, humid weather of late spring, summer and fall. Wool should be closely clipped over and for 3 or 4 inches beyond the infected area. Application of turpentine followed by pine tar or smear 62 is an effective treatment.

Injuries from dogs are treated by removing shreds of tissue surgically, then by washing the wounds with an aqueous sodium hypochlorite which is followed by the 10-percent sulfathiazole in glycerol.

Closed foot injuries are treated by applying a cotton pack to the area and wetting with saturated solution of magnesium sulfate. If the injury is open it is flushed with an aqueous solution of sodium hypochlorite, followed by the instillation of equal parts of ether and tr. iodine.

The Effect of the Addition of Sulfates of Copper, Zinc and Manganese on the Absorption of these Elements by Plants Grown on Organic Soils

LUCAS, R. E.

Soil Sci. Soc. Am. Proc. 10: 269-274. 1945. [Journal Article 794 (n. s.) from the Michigan Agricultural Experiment Station]

Both greenhouse and field experiments with organic soils indicated that applications of copper sulfate at the rate of 10 pounds per acre to copper-deficient soils resulted in large increases in copper content and in recovery of the plants growing on them. These applications had relatively little effect on manganese content, though in some crops intake of certain other elements was markedly increased and in others they were decreased. Increases in zinc absorption by the plant usually followed zinc applications. Such increases were often accompanied by decreases in copper and manganese content and sometimes by decreases in plant growth.

Time Studies on the Saving of Labor in Summer Work with Sugar Beets

BELL, R. W.

Proc. Soc. Sugar Beet Technologists. 4: 655-659. 1947. [Journal Article 796 (n. s.) from the Michigan Agricultural Experiment Station]

This article deals with the use of sheared beet seed and its effect upon labor saving in blocking and thinning as studied on the Ferden farm in 1945. Sheared seed was planted at different rates and records kept of the time required to block and thin each 90-foot row.

The greatest saving of labor was obtained when sheared seed was planted at the rate of 2.6 pounds per acre (about 7.7 seeds per foot).

The use of 2.5 pounds of sheared seed per acre resulted in a pre-blocking stand adequate for hand blocking and thinning, but it is imperative that the seeds be distributed quite evenly in the row.

Sugar Beets in Seven Michigan Systems of Crop Rotation

COOK, R. L., MILLAR, C. E., AND ROBERTSON, L. S.

Am. Soc. Sugar Beet Technologists Proc. Fourth General Meeting. 73-87. 1946 [Journal Article 797 (n. s.) from the Michigan Agricultural Experiment Station]

A crop rotation and sequence experiment designed especially to determine the effects of other crops on sugar beets is being conducted on Brookston sandy clay loam. Seven rotations are being compared at two fertility levels.

During two of the years 1941 to 1945 inclusive, the highest yields of sugar beets were obtained where the crop followed alfalfa. In 1944 the yields of beets following beans or corn were about equal to the yield obtained after alfalfa. In 1943 and 1945, seasons of excessive spring and summer rainfall, yields of beets were relatively low on all plots, but lowest where alfalfa was the preceding crop. If one considers 5-year averages, the highest yields of beets have occurred where beets followed alfalfa and the lowest yields have come from the plots where there is no legume in the rotation. Alfalfa in the rotation has caused higher yields than has sweet clover, and one year of alfalfa in a 5-year rotation has given as good results as two years of the legume. Red clover and sweet clover have been about equal in their effect on sugar beet yields.

Sugar beet yields have been significantly higher where the fertilizer application has been at the rate of 1,000 pounds per acre in 5 years than where the rate has been 400 pounds.

Corn yields have been markedly increased by the production of legumes in the rotation. Highest yields were obtained where corn followed alfalfa. One year of alfalfa has been as good as two in the rotation. Red clover has been slightly inferior to alfalfa, insofar as affect on corn yields is concerned, and sweet clover has been the poorest of the three legumes.

Bean yields have been increased by soil building legumes in the rotation. Alfalfa has been superior to sweet clover.

Wheat yields have been increased by the plowing under of sweet clover green manure in the rotation.

Time Required for Making Flavor Judgments of Milk

TROUT, G. M.

Jour. Dairy Sci. 29 (7): 415-519. 1946. [Journal Article 798 (n. s.) from the Michigan Agricultural Experiment Station]

The average time required to make flavor judgments on 2,262 individual samples of milk was noted. This time ranged from a low of 2.9 seconds for "salty" milk to 8.2 seconds for "excellent" milk. The judgment times for "cheesy," "high acid," "rancid," "flat" and "oxidized" milk were between these extremes and were in the above order. The average judgment time for the 2,262 samples was 7.2 seconds per sample. Milk having off-flavors of slight intensity required considerably longer judgment time than those having pronouncedly intense off-flavors. "Excellent" flavor milk invariably required longer judgment time than did off-flavor milk.

Prevention of Sedimentation in Apple Juice Clarified by the Enzymic Method

MARSHALL, R. E.

Am. Soc. Hort. Sci. Proc. 47: 75-78. 1946. [Journal Article 803 (n. s.) from the Michigan Agricultural Experiment Station]

In 1943, the author presented evidence showing that a small amount of 140-grade, powdered, apple pectin added to enzymic-clarified apple juice just prior to flash pasteurization prevented the possible formation of an unsightly, amorphous sediment in the bottoms of containers some 2 to 6 months after packing.

The tests reported in this paper were designed to determine the minimum amounts of 50-grade liquid, apple pectins that can be recommended to accomplish practical results. Nine concentrations ranging from 0.012 to 0.88 percent (1.5 to 112.7 ounces per 100 gallons of juice), in addition to controls, were used with juice packed from both the 1943 and 1944 crops apples. After 6 months' storage at room temperature, the bottom ends of the cans were removed, with the adhering sediment, and the sediment allowed to dry for 24 hours, when the net weights of the sediment were obtained.

Non-acidulated, starch-free, 50-grade, liquid apple pectin used in 1943-44 at the rate of 0.017 percent (2.1 ounces per 100 gallons juice) reduced sedimentation significantly compared with the controls. A concentration of 0.056 percent (7.2 ounces per 100 gallons juice) gave significantly better results than 0.017 percent, and 0.113 percent (14.4 ounces per 100 gallons) reduced sedimentation

significantly below 0.056 percent. Greater concentrations resulted in somewhat less sedimentation but the reductions were not statistically significant.

Acidulated, non-starch-free liquid pectin of similar grade was found to be much inferior to the non-acidulated, starch-free form.

Little sedimentation resulted in any of the treatments, including the controls, packed in 1944-45, but a significant reduction in sedimentation resulted from concentrations equalling or exceeding 0.039 percent (5 ounces per 100 gallons) compared with controls, with no significant gains resulting from high concentrations of the non-acidulated starch-free pectin.

It is suggested that the addition of 5 to 10 ounces of non-acidulated, starch-free, liquid apple pectin of 50 grade should reduce sedimentation of enzymic clarified juices to negligible amounts in most cases.

Measuring Detergency Functions as Affected by Various Detergents and Procedures against Milk Films by Application of a Mechanical Washing Apparatus

JENSEN, J. M.

Jour. Dairy Sci. 29 (7): 453-463. 1946. [*Journal Article 805 (n. s.) from the Michigan Agricultural Experiment Station*]

Detergency studies were made on various types of washing products by washing raw milk films from glass surfaces by a devised mechanical apparatus and measuring results in terms of light transmission by use of a Cenco-Sheard spectrophotelometer. An appreciable difference was observed in detergency as affected by detergent material and variations in washing procedure that was measured by light transmission readings. Highest detergency values were secured with solutions prepared of near-neutral wetting agent and metaphosphate mixtures. Next in order of detergency were slightly alkaline wetting agent detergent, alkaline salts containing wetting agent, alkaline salts containing metaphosphate, and acid detergent solution which gave lowest and entirely inadequate detergency. Prerinsing effects demonstrated depressive detergency action with both hard and soft water with all detergents except acid. Better detergency was secured with soft water than with hard water. Highly improved detergency was attained when prerinsing with water containing metaphosphate in slight excess of that required for sequestration of water hardness. After rinsing effects demonstrated improved detergency with alkaline detergents. However, soft water for final rinse gave better results than hard water. When wetting agent-metaphosphate detergent was used and the final rinse contained 0.10 and 0.15 percent metaphosphate in water containing 300 to 320 p.p.m. hardness, high light-transmission readings were maintained through repeated washing trials. Highest and practically complete detergency, as measured by light transmission, occurred when 0.10 and 0.15 percent wetting agent-metaphosphate detergents were used in the final rinse.

The Relation between Age, Number, and Types of Cells in the Peripheral Circulation of Chicken Embryos under Normal and Experimental Conditions

FENNELL, R. A.

Jour. Agr. Res. 74: 217-239. 1947. [*Journal Article 806 (n. s.) from the Michigan Agricultural Experiment Station*]

All hatching eggs used for experimentation were obtained from lines of Single-Comb White Leghorn chickens which showed various degrees of resistance and susceptibility to the avian leucosis complex. The objectives of the study were: (1) To identify and ascertain the mean percentages of the various cell types in

the peripheral circulation of inbred embryos of various ages from lines of chickens which showed various degrees of resistance and susceptibility to lymphomatosis; and (2) to study the effects produced on the peripheral blood of embryos by the injection of both normal and pathological tissues.

Primitive and definitive generations of blood cells were identified in the peripheral blood of chicken embryos. Primitive erythroblasts and hemocytoblasts were predominant types until about the seventh day of incubation. Histiocytes, basophilic and acidophilic myelocytes, giant cells, thrombocytes, polymorphonuclear neutrophilic leucocytes, and degenerating cells were found in smaller numbers. The definitive generation appeared in significant numbers on about the seventh day. Immature erythroblasts of the definitive generation were smaller and contained less hemoglobin than immature erythroblasts of the primitive generation.

The peripheral blood of chicken embryos approached stability on about the ninth day of incubation. The mean percentage of primitive erythroblasts, primitive erythrocytes and definitive erythroblasts decreased to 5.14, 1.85 and 1.88, respectively, while the definitive erythrocytes increased to 90.22.

Both the total number and frequency of occurrence of hemocytoblasts were higher in the peripheral blood from resistant lines 10 and 13 than they were in susceptible lines 7 and 11. The evidence suggests, but does not demonstrate, that increased numbers of hemocytoblasts in the peripheral blood may be closely correlated with resistance to lymphomatosis. Other factors may be correlated with resistance since embryos receiving RPL-17 tumor mince by yolk sac injection showed a peripheral blood picture which was essentially the same as uninjected control embryos.

The percentages of the various cell types in the peripheral blood of adult chickens with lymphomatosis differed from those found in the peripheral blood of embryos from resistant lines 13 and 10. In the former the peripheral blood of some adult birds showed increased numbers of immature cells of the red cell series, and in others there was increased numbers of myeloblasts; in the latter (resistant embryos) all cells other than hemocytoblasts were essentially normal morphologically as well as numerically.

The mean percentages of definitive erythrocytes in the peripheral blood of embryos (161-167 hours' of incubation) from resistant lines 13, 10, and susceptible lines 11 and 7 were 73.05, 65.85, 60.37, and 40.46, respectively. These data indicate that differentiation of blood cells in susceptible lines 11 and 7 was inhibited to a greater degree than it was in resistant lines 13 and 10.

The mean percentages of primitive erythroblasts, primitive erythrocytes, hemocytoblasts, thrombocytes and acidophilic myelocytes were increased and definitive erythrocytes were decreased by the injection of the yolk sac with grossly normal liver mince prior to incubation. Percentage death of embryos within 5 days was sixty-seven percent.

Composition of Fresh and Storage Eggs from Hens Fed Cottonseed and Non-Cottonseed Rations. II. Ammonia Nitrogen Content

BANDEMER, S. L., SCHAIBLE, P. J., AND DAVIDSON, J. A.

Poultry Science. 25: 446-450. 1946. [Journal Article 808 (n. s.) from the Michigan Agricultural Experiment Station]

In fresh eggs, the ammonia nitrogen content is relatively low and mainly in the yolk. Increased temperatures increased the rate of ammonia nitrogen production in the yolk, except in the case of fertile eggs at 38.5° C.

During cold storage of eggs from hens fed non-cottonseed rations, the concentration in the yolk increased gradually until it had practically doubled in 10 months; the white remained unchanged.

During cold storage of eggs from hens fed cottonseed rations, the concentration was reduced about a third in the yolks and increased approximately six times in the whites, provided the eggs showed injury as indicated by olive or salmon yolks and pink whites. Stored eggs showing no injury were very similar to the stored non-cottonseed eggs.

No significant statistical differences were obtained in the ammonia nitrogen content because of holding eggs 1 or 5 days at 13° C. before cold storage, to changes in feeding regimes, to differences in the breed of chickens or to imperfections observed in the eggs.

It is suggested that the determination of ammonia nitrogen concentration in the yolks rather than in the whole mixed egg could be used as a sensitive index of deterioration since it occurred in the yolk alone and could serve to distinguish fresh eggs accorded good treatment.

Composition of Fresh and Storage Eggs from Hens Fed Cottonseed and Non-Cottonseed Rations. III. Iron Content

SCHAIBLE, P. J., AND BANDEMER, S. L.

Poultry Science. 25: 451-452. 1946. [Journal Article 809 (n. s.) from the Michigan Agricultural Experiment Station]

During storage of eggs from hens fed a non-cottonseed ration, there is a small increase of iron in the whites and a small decrease in the yolks.

During storage of eggs from hens fed a cottonseed ration, if the eggs showed no discoloration, the iron levels in both the whites and yolks were similar to the corresponding non-cottonseed eggs. Discolored eggs showed a considerable increase in iron in their whites and a decrease in the yolks; eggs with pink whites and yolks had a greater iron content in the whites than did eggs with transparent or olive yolks.

Composition of Fresh and Storage Eggs from Hens Fed Cottonseed and Non-Cottonseed Rations. IV. Spectrographic Examination of Egg Whites

BANDEMER, S. L., AND SCHAIBLE, P. J.

Poultry Science. 25: 453-455. 1946. [Journal Article 810 (n. s.) from the Michigan Agricultural Experiment Station]

Similar absorption curves were obtained from whites of fresh eggs and stored eggs from hens receiving non-cottonseed rations, and from normal-appearing and discolored whites of stored eggs from hens fed cottonseed rations.

In the ultraviolet, the absorption maximum and minimum were characteristic of proteins containing aromatic amino acids.

In the visible, absorption differed from the carotenoid pigments normally found in yolks and from riboflavin, iron, cottonseed oil, cottonseed meal extract, and gossypol.

Composition of Fresh and Storage Eggs from Hens Fed Cottonseed and Non-Cottonseed Rations. V. Causes of Discoloration

SCHAIBLE, P. J., AND BANDEMER, S. L.

Poultry Science. 25: 456-459. 1946. [Journal Article 811 (n. s.) from the Michigan Agricultural Experiment Station]

Addition of iron in the concentration similar to that found in egg yolk, produced in fresh egg white a pink color which was deepest at pH 10.

Natural pink white from stored eggs from hens fed cottonseed rations and pink whites produced by adding iron to fresh white were fractionated with ammonium sulfate. The pink color was identified with the conalbumin fraction which crystallized as spheroids.

Fresh white was also fractionated, and the conalbumin fraction was the only one to give a pink color when treated with iron.

Discoloration of whites of stored eggs from hens fed cottonseed rations is attributed to the diffusion of iron through the vitelline membrane of the yolk and its reaction with conalbumin. The salmon color of the yolk is attributed to the diffusion of conalbumin into the yolk, its reaction with iron to produce a pink color and the blending of this color with the yellow of the normal yolk.

Observations on Hybridizing Lowbush and Highbush Blueberries

JOHNSTON, S.

Am. Soc. Hort. Sci. Proc. 46: 199-200. 1946. [Journal Article 812 (n. s.) from the Michigan Agricultural Experiment Station]

Records of 304 hybrids of certain highbush and lowbush blueberry selections showed that 97 percent of them had inherited the lowbush habit of growth, 65 percent produced berries of very dark blue color and all of them produced berries of about the same size as those produced by the lowbush parents, which is rather small.

Sporadic Diseases of Sheep. II. Kidney Infection, Urinary Calculi, Diphteritic Laryngitis, Meningitis and Encephalitis

THORP, F., AND COLE, C. L.

M.S.C. Veterinarian. 6: 22-23. 1946. [Journal Article 813 (n. s.) from the Michigan Agricultural Experiment Station]

Kidney infections result from invasion by bacteria belonging to the genus Corynebacterium. In the female the course of the disease is characterized by gradual emaciation and death. In the male symptoms not unlike urinary calculi develop. The finding of bacteria in the urine differentiates this condition from urinary calculi.

Urinary calculi is chiefly a disease of rams or feedlot wethers. Immediate surgery affords the best method of relief for such animals.

Diphtheritic laryngitis usually occurs in the fall or winter. Oral administration of sulfathiazole has been of value in treating this condition.

Meningitis and encephalitis usually result from the extension of a suppurative sinusitis through the cribiform plate of the ethmoid to the brain. No treatment has been found satisfactory.

Palatability and Ascorbic Acid Retention of Rutabaga, Peas, and Cabbage after Holding on the Steam Table

KELLEY, L., JACKSON, M., SHEEHAN, K., AND OHLSON, M. A.

Jour. Am. Diet. Assoc. 23 (2): 120-124. 1947. [Journal Article 821 (n. s.) from the Michigan Agricultural Experiment Station]

The effect of various steam table holding practices on the total ascorbic acid content and palatability of rutabaga, fresh green peas, and cabbage containing 30.2, 22.6, 50.2 mg. ascorbic acid per 100 grams, respectively, was studied. Reductions in the amount of vitamin in 100-gram portions of moist vegetable resulting from controlled cooking procedures were 33 percent in rutabaga, 35 percent in peas, 46 percent in 3-inch cabbage wedges, and 55 percent in 1-inch cabbage wedges. Total reduction of ascorbic acid due to both cooking and retention on 90° to 100° C. steam tables for 60 minutes ranged from 46 to 66 percent.

Variation in ascorbic acid reductions in cooked vegetable drained, mashed, buttered, or covered with cooking liquid and held on the steam table was not significant as compared with variations in ascorbic acid reductions due to steam table holding times of 0, 15, 30, and 60 minutes and to steam table holding temperatures.

The range of reduction in ascorbic acid content of cooked vegetables held on a steam table for 60 minutes was 7.7 to 37.9 percent at 90° C. and 21.4 to 48.7 percent at 100° C. Higher steam table temperatures did not result in appreciably greater deterioration of vegetable until after 30 minutes of steam table holding.

Scores for eating quality tended to correlate with changes in vitamin content.

Storage and Treatment of Milking Machine Inflations

JENSEN, J. M., AND BORTREE, A. L.

Jour. Dairy Sci. 29: 849-859. 1946. [Journal Article 823 (n. s.) from the Michigan Agricultural Experiment Station]

Absorption and deterioration of synthetic rubber milker inflations were studied. Synthetic inflations stored in sanitizing solution were found to absorb various quantities of such solutions during storage. Significantly higher quantities were absorbed when the inflations were treated by daily working in whole milk for a one-minute period followed by solution storage. Inorganic chlorine solutions caused greatest deterioration to synthetic inflations as exhibited by color change, roughening and dissolving conditions on the surface. Lowest absorption occurred when lye solution was used for storage. A slightly tacky feel developed on the surface of inflations stored in acid and the cationic surface-active sanitizing agent, "Roccal."

A method for determining absorbed fat is described. Highest quantities of fat were absorbed in the mouth or upper portion of inflations. Boiling inflations in lye solution decreased the fat content and greatly reduced the moduric bacterial contamination.

Thinning Apples at Blossom Time with Growth Regulating Substances and Oil-Wax Emulsion

Stebbins, T. C., Neal, A. L., and Gardner, V. R.

Am. Soc. Hort. Sci. Proc. 48: 63-66. 1946. [Journal Article 826 (n. s.) from the Michigan Agricultural Experiment Station]

Appl-L-Set, a trade preparation of the sodium salt of naphthyl acetic acid, in concentrations of 10 to 20 parts per million, proved an effective thinning agent for apples when applied as a spray during or shortly after the full bloom stage. It caused very little injury to the foliage.

DN Dry-Mix, a dinitro compound used at concentrations of ½ to 1 pound per 100 gallons of water was likewise an effective thinning agent when applied at the full bloom stage, but resulted in considerable foliage injury.

The oil-wax emulsions, developed at the Michigan Station and designated as Nos. 82 and 222, in dilutions of 1 to 100 effected some thinning of the fruit where applied at blossoming and without any apparent injury to fruit or foliage, but they were less effective than the two preceding materials.

Effectiveness of all of the materials used varied considerably with the variety, McIntosh being the most sensitive, Duchess the least and Wealthy intermediate of the varieties employed.

The Relationship of Brucellosis to Human Welfare

Huddleson, I. F.

Ann. N. Y. Acad. Sci. 48: 415-428. 1947. [Journal Article 827 (n. s.) from the Michigan Agricultural Experiment Station]

This paper points out some of the important major aspects of the brucellosis problem: the nature in which they affect human welfare, in general, and the cattle and hog raising industry, directly.

The Effect of Bottom Heat on the Yield of Forced Rhubarb

Bjornseth, E. H.

Am. Soc. Hort. Sci. Proc. 48: 363-368. 1946. [Journal Article 828 (n. s.) from the Michigan Agricultural Experiment Station]

Experiments in the forcing of rhubarb at an air temperature of 10° C. showed that bottom heat that raised the soil temperature to 13°-18° C. caused a very substantially larger early yield, though this was accompanied by a slight decrease in grade of product. Higher soil temperatures resulted in very substantial decreases in grade and were undesirable.

The Effect on Yield of Freezing and Various Ethylene Treatments in Breaking the Dormancy of Rhubarb

Bjornseth, E. H.

Am. Soc. Hort. Sci. Proc. 48: 369-373. 1946. [Journal Article 829 (n. s.) from the Michigan Agricultural Experiment Station]

Exposure of rhubarb roots and crowns intended for forcing to ethylene gas, 2 parts to 1,000 parts of air for 12-24 hours, was found to be a satisfactory substitute for freezing as a means of breaking their rest period. Longer exposures (e.g. 60-72 hours) resulted in injury to the crowns and roots.

Sanitizing Dishes

MALLMANN, W. L., KIVELA, E. W., AND TURNER, G.

Soap and Sanitary Chemicals. (4 pp.). Aug., 1946. [Journal Article 831 (n. s.) from the Michigan Agricultural Experiment Station]

Field testing, using 400 to 800 glasses, showed that 5 gallons of hypochlorite (180 p.p.m. available chlorine) or cationics ("Roccal", "B.T.C.", "Hyamine 1622") 1-6400 would sanitize 800 glasses effectively with an exposure of approximately 30 seconds. The presence of neutralizing agents in the cleaners (wetting agents and polyphosphates) had no effect on the sanitizing value of cationics when 800 or less glasses were sanitized using both two- and three-tank systems of washing and sanitizing.

Sporadic Diseases of Sheep. III Installment. Overeating, Founder, Constipation and Pneumonia

THORP, F., AND COLE, C. L.

M.S.C. Veterinarian. 6: 77, 87. 1946. [Journal Article 832 (n. s.) from the Michigan Agricultural Experiment Station]

Overeating results from the consumption of too much carbohydrate feed. The condition can be controlled by good management practices.

Founder may occur under conditions of management similar to those seen in overeating. The digestive tract should be emptied by means of soapsuds enemas and 1/8 gr. of arecoline subcutaneously. Those animals that continue to walk usually recover.

Constipation occurs during the winter when the animals are on dry feed. Insufficient water and irregular feeding contribute to the condition. Satisfactory treatment consists of soapsuds enemas, one mg. of lentin subcutaneously and 3 to 4 ounces of mineral oil. If the animals do not drink water, 2 quarts of warm water can be given by stomach tube.

Pneumonia can be successfully treated by administering orally 2 gr. of sulfathiazole per pound of body weight per day divided into two equal doses 12 hours apart.

Malformation of Beaks of Chicks Caused by Rations Containing Egg White

SCHAIBLE, P. J., BANDEMER, S. L., AND DAVIDSON, J. A.

Poultry Science. 26 (2): 206-207. 1947. [Journal Article 837 (n. s.) from the Michigan Agricultural Experiment Station]

When chicks were fed rations containing high levels of uncooked egg white, they developed, after several weeks, a dermatitis of a pellagrous character, involving the feet, corners of the mouth and the eyelids. This condition is similar to that observed in biotin deficiency.

In addition to these symptoms previously reported such chicks developed abnormal beaks. The upper and lower mandibles did not meet properly and finally became so distorted laterally, that they crossed each other, as in the crossbill finch.

Crystals Observed in Fresh and Storage Eggs

SCHAIBLE, P. J., AND BANDEMER, S. L.

Poultry Science. 26 (2): 207-209. 1947. [Journal Article 842 (n. s.) from the Michigan Agricultural Experiment Station]

On breaking out eggs that had been in cold storage for several years, it was observed that some of them contained curdy masses just beneath the yolk membrane. Microscopic examination showed these curds were crystals in the form of rosettes. Similar rosettes or single crystals were found in the yolk material and crystals with a different formation were present in the white.

Crystals were found in the firm white of freshly laid eggs and appeared in the thin white as the age of the egg increased. None was found in the yolks until the eggs were one year old.

A method for separating the crystals from the egg material is given. A possible composition of the crystals is suggested.

Sporadic Diseases of Sheep. IV. Ketosis and Uterine Eversion

THORP, F., AND COLE, C. L.

M.S.C. Veterinarian. 7: 30, 42-43. 1946. [Journal Article 848 (n. s.) from the Michigan Agricultural Experiment Station]

The following factors are considered to be important in the development of ketosis in sheep. (1) Lack of suitable carbohydrate in the diet. (2) Failure to feed regularly. (3) Sudden change of environment. (4) Sudden starvation. (5) Intercurrent infection and parasitism. (6) Anything which may interfere with the normal metabolism of the animals.

As a preventive measure, the breeding flock should receive a ration of sufficient amount to provide for maintenance and some gain over and above the weight of the fetus or fetuses. The flock can be treated by increasing the amount of carbohydrate in the ration and by adding 1 or 2 ounces of molasses per ewe per day poured over the feed.

The Use of New Insecticides in the Control of Potato Insects

MOROFSKY, W. F., AND MUNCIE, J. H.

American Potato Journal. 24 (5): 162-166. 1947. [Journal Article 855 (n. s.) from the Michigan Agricultural Experiment Station]

At the Lake City, Michigan Experiment Station during the season of 1946, 17 combinations of insecticides and fungicides in sprays and 12 combinations as dust were used in control of potato leafhoppers, six-spotted leafhoppers, spittle bugs, tarnished plant bugs and flea beetles. Aphids were practically absent.

Counts made 24 hours and 5 days after application showed no significant difference in control of potato leafhopper in either spray or dust plots. Residual effect of dusts 9 days after application was considerably better than that of sprays in control of potato leafhoppers.

None of the materials used gave as good control of six-spotted leafhoppers as did DDT in combination with fungicide.

There was no appreciable difference among any of the materials used as sprays or dusts in control of spittle bugs, tarnished plant bugs, and flea beetles.

In general, DDT in combination with fungicides as sprays or dusts gave better control of potato insects than any of the other materials used.

Inactivation of 2,4-D by Adsorption on Charcoal

LUCAS, E. H., AND HAMNER, C. L.

Science. 105 (2726): 340. 1947. [Journal Article 859 (n. s.) from the Mic Agricultural Experiment Station]

The toxic effects of 1 to 1,000 2,4-D solutions have been found to be inhib by shaking and mixing with 1-percent activated charcoal. The suggestion is mad that activated charcoal may be used to inactivate the residue that is very difficu to remove from spraying equipment and other containers.

The Influence of Agitating the Freshening Water on the Desalting of Pickles

FABIAN, F. W., AND JACOBS, P. D.

Fruit Products Jour. 26 (8): 230-232, 253. 1947. [Journal Article 867 (n. s.) fro the Michigan Agricultural Experiment Station]

The freshening of pickles is one of three processes in making pickles. T present work was a study of the influence of agitation by compressed air on tl rate of withdrawal of salt during the freshening process. The work was do under commercial conditions. The pickles were vat-run, ranging in size fr 600 to 1,800 for one series of experiments and for a second series of experimet they were No. 2 machine-graded pickles, including 4,500, 6,000 and 8,000 A comparison was made between agitation and non-agitation of the freshenii water on the rate of the withdrawal of the salt.

Agitation of the freshening water with compressed air does in most ca facilitate the withdrawal of salt from pickles. However, the advantage was slig The difference in time in most cases was about one hour. There was a differen in the salometer reading of the brine and the actual amount of salt present the pickles, especially when there was a small amount of salt in the bri It required more heat when the tanks were agitated than when they were n There was no noticeable difference in turgidity in the small size and only a slig difference in the larger sizes. The conclusion was that the advantage of agitat pickles with compressed air was slight when the water was heated by mea of a steam siphon as was done in these experiments.

The QUARTERLY BULLETIN

MICHIGAN STATE COLLEGE

Agricultural Experiment Station

EAST LANSING - - - - - - - - - MICHIGAN

LUME 30 - - - - NOVEMBER 1947 - - - - NUMBER 2

CONTENTS

(Continued on Next Page)

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: (1) progress reports on long-term major research projects; (2) final reports on short-term projects and (3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

CONTENTS

(Continued from Outside Front Cover)

USE OF 2-METHYL-4-CHLOROPHENOXYACETIC ACID AS A PREHARVEST SPRAY TO PREVENT DROP OF McINTOSH APPLES

By A. E. MITCHELL, C. L. HAMNER *and* WALTER TOENJES
SECTION OF HORTICULTURE

DROPPING OF FRUIT prior to and during harvest is a serious fault of the McIntosh apple. Naphthaleneacetic acid and certain of its derivatives are widely used to overcome this varietal weakness, but these chemicals have limitations and are effective for only a short period. A relatively new growth regulator, 2,4-dichlorophenoxyacetic acid, has proved ineffective in delaying abscission of fruit of McIntosh (1, 4). However, it has been found to have selective characteristics and to delay fruit abscission effectively and specifically on the Stayman and Winesap varieties (2, 3). Since 2,4-dichlorophenoxyacetic acid seemed to be specific for these two varieties, it was conjectured that perhaps other chemicals, closely resembling 2,4-dichlorophenoxyacetic acid in chemical structure and composition, might be specific for other varieties such as McIntosh. Among those that suggested themselves was 2-methyl-4-chlorophenoxyacetic acid which differs from 2,4-dichlorophenoxyacetic acid only in the replacement of the two-position chlorine atom with a methyl molecule. Accordingly, the following experiment was undertaken to test this compound for its capacity to check fruit drop on McIntosh apple trees.

Twelve mature McIntosh trees, located at the Graham Experiment Station of the Michigan State College, were selected for the study. All trees carried a medium-to-full crop of fruit and, although growing in the same environment in sod, they varied somewhat in size. They were divided into three groups of four trees each, taking into consideration their size differences. The three group treatments were as follows: (a) Niagara Sprayer and Chemical Company naphthaleneacetic acid dust applied as a wet dust; (b) 2-methyl-4-chlorophenoxyacetic acid applied as a spray at 20 p.p.m.; (c) check, no treatment. The crystals of 2-methyl-4-chlorophenoxyacetic acid were first dis-

ARTICLE 30-15

solved in 95-percent ethyl alcohol and the resulting solution was then added to the water in the sprayer tank.

The first application of materials was made September 17, 1947. The weather was bright and clear, with a slight breeze. The 2-methyl-4-chlorophenoxyacetic acid was applied at approximately 9 a.m. when the air temperature was 61° F. and the dust treatment was made between 7 and 8 p.m. when the air temperature was 70° F. There was a very slight breeze during the period the dust was applied. The trees were dusted and sprayed thoroughly from opposite sides to insure complete coverage. The minimum air temperature for the following 24 hours was 62° F. and the maximum 83° F. which is relatively high for this season of the year. Warm weather continued for 3 more days, at which time the temperature dropped below the average for the season and remained so for a period of 10 days. A second application was made 8 days later because the fruit was still immature and naphthaleneacetic acid is usually ineffective after 7 to 9 days. The 2-methyl-4-chlorophenoxyacetic acid was applied September 27, 1947, at approximately 4 p.m. and the dust treatment was made 3 hours later when there was only a slight breeze. The air temperature at 4 p.m. was 50° F., but it had dropped to 45° F. by 7 p.m. and reached a minimum of 31° F. during the night. The next day the air temperature did not go above 56° F. and remained relatively low for the next 7 days. This cool weather was followed by seasonal temperatures.

The number of fruit drops was recorded at 2- and 3-day intervals from September 20, 1947, until October 6, 1947. From this date until the end of the experiment, records were taken at daily intervals with one exception, October 12. The commercial picking date for McIntosh apples was considered approximately October 8, 1947. At this time two check trees and three trees treated with naphthaleneacetic acid were harvested. The fruit was allowed to remain on the other experimental trees so as to observe the effectiveness of the hormone materials over a longer period of time.

The drop of fruit from the untreated trees became appreciable about 4 days before commercial harvest and amounted to 48.52 percent at the time of harvest, October 8, 1947. By contrast, the fruit on trees treated with naphthaleneacetic acid had dropped only 5.08 percent four days before commercial harvest and 10.90 percent on the date of harvest. Best of all were the trees treated with 2-methyl-4-chlorophenoxyacetic acid on which the drop was only 4.74 percent four days before harvest and only 5.13 percent at the time of harvest.

The most striking results were secured, however, from the trees on which the fruit was allowed to hang beyond the commercial date (October 8). For example, one week later (October 15), the drop from untreated trees reached 91.74 percent of the crop compared with only 13.55 percent from trees treated with 2-methyl-4-chlorophenoxyacetic acid and 71.18 percent from the unharvested tree treated with naphthaleneacetic acid. By the end of the test (October 17), 9 days after commercial harvest, the drop from trees treated with 2-methyl-4-chlorophenoxyacetic acid was 23.99 percent, compared with 94.89 percent on untreated trees and 76.85 percent on the unharvested tree treated with naphthaleneacetic acid.

The detailed record is given in Table 1.

While the results from this preliminary test with 2-methyl-4-chlorophenoxyacetic acid suggest its value as a material to retard the drop of McIntosh fruit, there are several points that should be considered. First, the weather was unusually warm prior to and for several days after treatment. A cool spell followed, which was in turn followed by warmer but seasonal air temperatures. Under these conditions, the dropping of fruit was accelerated. Whether these conditions were unduly favorable to 2-methyl-4-chlorophenoxyacetic acid can be determined only by additional work. Further, there remains the possibility of strain differences in the trees treated and in the effect of 2-methyl-4-chlorophenoxyacetic acid on these strains; that is, the trees used in this experiment were in a block of bud sports of McIntosh (Table 1). In previous years no evidence has been noted of any difference in fruit drop among these bud sports. Also, the single check tree of Strain 430 may be compared directly with the single tree of the same strain treated with 2-methyl-4-dichlorophenoxyacetic acid from which 91.81 percent of the fruit on the check tree had dropped on October 17, 1947, when only 33.31 percent had dropped from the treated tree. Nevertheless, this factor remains which can be eliminated only by further tests.

The results of this preliminary work with 2-methyl-4-chlorophenoxyacetic acid show sufficient promise to justify the continuation of a more extensive research program in the use of this material to reduce preharvest drop of McIntosh apples.

TABLE 1—*The effect of 2-methyl-4-chlorophenoxyacetic acid spray and of naphthaleneacetic acid wet dust as preharvest treatments to reduce apple drop of McIntosh*

Treatment[1]	Tree No.	Bud selection No.	Cumulative percent drop at given dates									
			9/24	10/1	10/4	10/6	10/8	10/10	10/13	10/15	10/17	10/31
2-methyl-4-chlorophenoxyacetic acid 20 p.p.m.	3E[3].......	523........	4.50	5.05	5.59	5.59	5.59	6.85	7.75	8.65	13.69	59.10
	3G.......	523........	3.47	4.09	4.34	4 34	4.59	4.83	4 96	6.2	....	....
	3I.......	523........	2.62	3.03	3.21	3.35	3.53	3 90	9.31	15 23	21.98	....
	10K.......	430........	2.44	3.57	4.35	5.67	6.79	8 01	16.17	24.13	33 31	....
Average..................................			3.26	3.94	4.37	4.74	5.13	5.90	9.55	13.55	23.99	....
Naphthaleneacetic acid dust[2]	11F.......	245........	0.91	1.38	1 76	4.10	10.38[4]	....	....	....	....	....
	11H.......	245........	1.41	1 69	2.44	4.36	11.12[4]	....	....	....	....	....
	11J.......	430........	2 58	3.31	3.98	5.30	8.71[4]	....	....	....	....	....
	11L.......	431........	1.68	2.97	3.94	6.56	13.37	25.30	59 32	71.18	76 85	....
Average..................................			1 65	2.34	3.03	5.08	10.90	25.30	59 32	71.18	76.85	....
Untreated	10E.......	251........	1.68	2.59	3.65	8.31	27.42[4]	....	....	....	....	....
	10G.......	238........	0.64	1.03	1 22	11.0	66.30[4]	....	....	....	....	....
	10I.......	238........	1 70	2.74	4.23	12.82	63 15	83.98	93.49	95.35	97.97	....
	10M.......	430........	3.00	4.75	6 48	13.04	37.20	55 94	81.23	88.12	91.81	....
Average..................................			1 76	2.78	3.90	11 29	48 52	69 96	87.36	91.74	94.89	....

[1]First application made September 17, 1947. Second application made September 25, 1947.
[2]A commercial product of the Niagara Sprayer & Chemical Company
[3]Fruit on this tree was not harvested and the number of drops are being recorded at regular intervals
[4]Harvested at the time of commercial harvest, October 8, 1947.

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BEEF COSTS AND RETURNS IN NORTHEASTERN MICHIGAN, 1946

*By K. T. WRIGHT**
SECTION OF FARM MANAGEMENT

MANY FARMERS, county agricultural agents, and agricultural teachers have expressed a desire for information on the financial aspects of the beef cattle enterprise and the relationship between practices followed and results obtained. In response to this need and a specific request by the Northeastern Michigan Hereford Calf Association, with an offer to cooperate in keeping records, a study was started in April, 1946. Results of the first year have been summarized and are presented in this article.

The 21 farmers included in this study operated farms averaging about 500 acres in size. Almost one-half of this acreage was permanent pasture. In addition, there was about 90 acres in woods not pastured, roads and waste, leaving about 170 acres of tillable land. Livestock per farm averaged about 30 beef cows, nearly 20 beef yearlings, 7 dairy cows, 40 hens, and about 7 hogs.

Cow Costs and Returns – The cost of keeping a beef cow in 1946 in this area, according to the records submitted, averaged $63. The accompanying table shows that $36, or somewhat more than half of this total cost was for feed. About one-third of this was for the eight months April 1 to December 1, and two-thirds for the winter. These beef cows were on pasture nearly 7 months, and in the course of the year were fed just slightly more than 100 pounds of grain, which included that fed to the small calf during summer or early fall. Total roughage consumed per cow was approximately 1¼ tons of hay and about one ton of other roughages. All feed was charged at market prices.

Among the other items of costs, interest on the investment in the cow and the charge for labor were the two largest items. Costs listed under "other items" were as follows: share of farm overhead $2.92, death loss in cows $1.93, veterinary $1.08, and salt and mineral $1.02 per cow.

*The late E. L. Benton, C. M. Harrison, and the following county agents assisted in this project: Casper Blumer, R. B. Coulter, W. L. Finley, and Paul Pennock.

TABLE 1—*Cow costs and returns per head on 17 herds, 1946*

Item	Average
Cows per farm at beginning of year	32
Death loss in year in cows (%)	1.3
Calves raised per farm	30
Percent calf crop	93
Calf weight per head at sale or December 1 (pounds)	396
Calf production per cow (pounds)	370
FEED FED PER COW	
Pasture (days)	201
Grain (to cow or calf) (pounds)	114
Hay (pounds)	2,673
Other roughage (pounds)	1,954
Hours of labor per cow in year	10
COSTS PER COW FOR YEAR	
Feed*	$36.11
Labor	6.44
Interest on cow value at 5%	6.97
Bull cost	3.38
Building and equipment	3.61
Other items	6.95
Total	$63.46
INCOME PER COW FOR YEAR	
Calf (sale receipt or December 1 value)	71.61
Cow appreciation	6.15
Total	$77.76
NET RETURN PER COW	14.30
RETURN PER DOLLAR FEED FED	1.40

*Feed prices—Grain, $2.43 a cwt., hay, $16.29 a ton; and silage, $5.88 a ton. (Pasture, $5.66 for season.)

The 537 cows on the farms in this study had a 93-percent calf crop. About 70 percent of the calves were sold at the West Branch sale, October 21, 1946. Practically all of the rest were kept for herd replacements. The average weight of the calf at sale date or on hand December 1, if kept, was 396 pounds a head. This amounted to 370 pounds of calf production a cow.

Calf income, from either sale or inventory, amounted to $71.61 a cow as an average (Table 1). In addition, there was an average appreciation in cows of $6.15 a head. This was the result of young cows increasing in value or the sale of cows above inventory value. The total income of $77.76 a cow left a net of $14.30 a head for the year. In other words, the income from the calves up to 6 or 7 months of age, plus the increase in cow value, paid the annual cost of keeping a cow and returned sufficiently to pay $1.40 for each dollar of feed fed.

If costs were figured on a per calf basis, the total cost a head amounted to $61.62. Since the calves averaged 396 pounds apiece, this is a cost of $15.56 a cwt. The average sale price and value of the calves was $19.34 a cwt., so there was a net return of $3.78 above costs (Table 1).

Low-Cost vs. High-Cost Herds—Cost of calf production on individual herds varied widely. To inquire into the causes and the effects on profits, a comparison was made of the five low-cost with the five high-cost herds. The average cost of producing calves on the low-cost group was $12.47 per hundred pounds (Table 2). This compares with $22.89 on the high-cost five.

The low-cost herds had twice as many cows. The calves were heavier. The cows were kept on pasture longer, and were fed less other feed during both the summer and the winter, with the exception of more grain during the winter. Feed cost per cow was almost $20 lower on the low-cost herds. "Other costs" also were less largely because there was less depreciation in the cows. Bull costs a cow were less because of the larger herds. The low-cost herds, besides being twice as large, were on farms averaging about 800 acres, compared with about 200 acres for the other group. It seems that low cost of production of beef cattle was more likely with a large farm and a large herd.

Gross income per cow on the low-cost herds was not quite so high as on the high-cost herds. This was caused by a slightly lower percentage calf crop and a lower average sale price. In spite of this lower income per cow, however, the net return was $24 a cow higher on

TABLE 2—*Comparison of low with high-calf-cost (per cwt.) herds*

Item	Low-cost 5	High-cost 5
Calf cost per hundred pounds	$12.47	$22.89
Cows per farm at beginning of year	36	18
Calves raised per farm	34	18
Percent calf crop	92	98
Calf weight per head (pounds)	398	373
Calf production per cow (pounds)	370	367
Calf sale price or value per cwt	$17.97	$21.41
FEED FED PER COW		
Pasture (days)	228	183
Grain (pounds)	181	138
Hay (pounds)	2,787	3,384
Other roughage (pounds)	791	2,670
Hours labor per cow in year	11	12
COSTS PER COW FOR YEAR		
Feed	$28.81	$48.41
Labor	7.4[illegible]	7.66
Other	15.76	28.00
Total	$52.00	$84.07
INCOME PER COW FOR YEAR		
Calf (sale and/or December 1 value)	66.47	78.64
Cow appreciation	4.54	.43
Total	$71.01	$79.07
NET RETURN PER COW	19.01	−5.00
RETURN PER DOLLAR FEED FED	1.66	.90

TABLE 3—*Yearling heifer costs and returns on five herds*

Item	Average
Heifers per farm at start	10
Death loss (%)	2.0
Weight per head at one year of age (pounds)	628
Weight per head at two years of age (pounds)	875
Gain in weight in year (pounds)	247
FEED FED PER HEIFER IN YEAR	
Pasture (days)	180
Grain (pounds)	175
Hay (pounds)	2,568
Other roughage (pounds)	1,071
Hours labor per heifer in year	8
COSTS PER HEIFER FOR YEAR	
Feed	$34.78
Labor	5.33
Interest on heifer value at 5%	5.73
Bull expense	3.72
Buildings and equipment expense	5.90
Death loss	2.04
Other	4.34
Total	$61.84
Value placed on yearling heifer (4/1/46)	105.10
Cost of raising for one year	61.84
Total	$166.94
Value of two-year-old heifer (4/1/47)	132.56
NET RETURN PER HEAD IN YEAR	−34.38
RETURN PER DOLLAR FEED FED	01

the low-cost farms than on the high. The net return on the cow herd averaged about $700 on the low-cost herds, while the high-cost group lost about $100 per herd on the cows.

Yearling Heifer Costs and Returns — Five farmers in this group had yearling heifers on their farms which were kept all year. The 49 heifers weighed an average of 628 pounds when one year old and 875 pounds a year later, a gain of 247 pounds (Table 3). The annual charge for feed amounted to about $35 per heifer. Other charges raised the total to about $60 a heifer for the year. In other words, the cost was about $24 a cwt. for the gain in weight.

These men placed an average value of $105 a head on their yearling heifers on April 1, 1946. Adding to this, the cost of raising each heifer, plus the charge as a result of 2-percent death loss, made a total cost of almost $167 a head for the 2-year-old heifer. The average value placed on these 2-year-old heifers was about $133 or $34 less than the value at the beginning of the year plus costs.

Actually, there was not that much loss, because the yearling heifer had cost less than the $105 value placed on her. The cost of calf production in 1946 shows costs of about $63 a head up to December 1,

and $30 from then to April 1, or a total cost of $93. This means that the total cost of the 2-year-old heifer was about $156, assuming 1946 costs on the first and second years. It should be remembered that in these costs all feed has been charged at market price and charges have been made for labor and all other items, including the farmers' own labor, at 65 cents an hour.

More profit was made last year in the production of the 6- or 7-month-old calf, which sold for $70 to $80 than in raising the calf from that age to one year, or in raising the yearling to a 2-year-old animal. In the case of the yearling heifers, where almost 250 pounds of gain was made in the year, there was only $27 increase in inventory value per head, according to the farmers' estimates. Either the yearling heifers were not worth the $105 value placed on them, the $132 was not enough for the 2-year-olds, or it didn't pay to raise heifers. Raising any more than needed replacements seems a questionable practice.

Bull Costs — The average cost of keeping bulls was about $78 a head for the year (Table 4). About $45 of this was for feed. Interest on the average value of $245 was the item next in importance. An average of nearly two bulls were kept per farm for 43 cows and heifers of breeding age. The cost of keeping the bull on each farm was charged against the cows and heifers. There was an average of

TABLE 4—*Annual bull costs on 17 herds, 1946*

Item	Average
Number of bulls	33
FEED FED PER BULL IN YEAR	
Pasture (days)	129
Grain (pounds)	407
Hay (pounds)	3,494
Other roughage (pounds)	1,308
Hours labor per bull in year	11
COSTS PER BULL FOR YEAR	
Feed	$44.80
Labor	7.16
Depreciation	4.67
Interest on bull value at 5%	12.14
Building use	4.09
Other*	4.72
Total	$77.58
INCREASE IN VALUE	0.00
NET COST PER BULL FOR YEAR	77.58
Bull cost per herd	151.38
Cows and heifers of breeding age per farm	43
Net bull cost per cow and heifer	$3.52

*No death loss.

22 females of breeding age for each bull. Consequently, bull cost amounted to $3.52 per head.

Entire Beef Herd — Not all of the 21 farmers who cooperated in this study had beef cows, raised heifers, and fed feeders. If, however, one were to assume that the total operations carried on by all these men were averaged, the average farm would have 26 cows, 24 calves, 18 yearlings, and 2 bulls. Costs on this average beef enterprise in 1946 were as follows: Value of feed about $1,700, consisting of 6 tons of grain, 25 tons of silage, 57 tons of hay and 12 tons of other roughage. The charge for about 450 hours of labor was slightly less than $300. Interest on investment on cattle at 5 percent was $275; charge for the use of the buildings was $170, while other costs amounted to $240. This made a total of $2,685 costs on beef for the enterprise of the size mentioned above.

Returns from the sale of cattle plus increase in value of any not sold averaged $3,430 per farm; thus, there was a net return in 1946 of $745 per farm. If this net were credited to the feed value it would mean a net return of $1.40 for every dollar's worth of feed fed.

Net returns on individual beef herds ranged from a loss of about $500 to a profit of approximately $3,500. What were the causes of these variations in net returns? Size of operation was an important factor. It was found that farmers producing less than 10,000 pounds of beef in a year just barely "broke even" as an average. On the other hand, those who produced more than 30,000 pounds of beef in a year made a net of about $1,850 per herd. Management practices were important. They were largely responsible for a difference of nearly $5.00 a cwt. in sale price of the calves, and some difference in costs. Some types of beef cattle operations were more profitable than others.

Low costs of production are essential for profit in beef cattle. Large scale beef cattle operations and a large farm help in getting low costs. It seems that the men with small farms, even though a good job was done with beef cattle, did not net so much a head as men with large farms and herds. Apparently beef cattle are more advantageous where there is a large amount of pasture and low-cost feeds. There are many places where beef cattle provide the best method of utilizing such pasture and feed efficiently.

The gross income per beef cow is considerably less than from a good dairy cow, so large operations are necessary to secure a sufficient gross income. A beef herd fits best in the farm operations where there

is a large acreage, inexpensive feed, a relatively small amount of labor available for livestock production, and where a high gross income is not needed.

It has been pointed out previously that while these farms averaged over 500 acres, there was only about 170 acres that was tillable. Half of this was in hay, and the rest in corn, small grain, tillable pasture, summer fallow, and other crops. An equivalent of 2¼ men were employed by these farms. The estimated total income averaged about $8,000 per farm. Over 40 percent of this total came from beef cattle; thus, it is apparent that beef cattle in 1946 contributed substantially to the income of the farmers cooperating in this study.

HOUSEWIVES' REACTIONS TO MICHIGAN POTATOES

By M. E. CRAVENS
SECTION OF ECONOMICS

BETWEEN February 21 and April 28, 1947, about 10,000 return postcards were placed in as many 15-pound bags of potatoes to learn what housewives thought of Michigan potatoes: Slightly over 300 of these were returned by consumers in Michigan, Wisconsin, and northern Illinois, Indiana and Ohio.

This study was designed to bring out any unfavorable consumer reactions to Michigan potatoes. For this, if for no other, reason the report will deal more with complaints than compliments.

WHY THEY SELECTED THE POTATOES

One-fourth of the purchasers gave the fact that the bags were marked "Michigan potatoes" as the reason for buying (Table 1). Next in importance as reasons for buying were cheapness, appearance of the potatoes and previous satisfaction with potatoes of the same "brand." About one housewife in ten purchased a bag of potatoes with the enclosed postcard because there was no other choice in her grocery.

TABLE 1—*Reasons given by housewives for buying "this bag of potatoes"*

Reason given	Percent of answers
Preferred Michigan potatoes	26
Cheaper	19
Looked good	14
Used before and liked them	12
Recommended	5
Attractively packaged	4
To try them	3
Other	6
No other choice available	11
Total	100

ARTICLE 30-17

It is not possible to separate and evaluate the importance of the answers above in Table 1. It is likely that some who reported that they bought because they were Michigan potatoes were influenced as much by the price and appearance of the potatoes. The fact that about as many outside Michigan as within the state gave this as their reason for purchasing indicates that factors other than state pride are primarily responsible. Almost one-fifth bought either on the basis of their own favorable experience with the brand or on the recommendation of others who had used and liked them. This emphasizes the great importance of a uniformly acceptable pack. It does not mean a "super" grade or size but it does indicate the importance of a uniform grade, size, quality and supply.

HOUSEWIVES' COMPLAINTS

The most common cause for dissatisfaction with Michigan potatoes was excessive grade defects, with cooking quality next in importance (Table 2). Cooking dark was the most common single cause for complaint, with sogginess and hollow heart next in importance, followed by dirtiness and rotten spots. A question on the complaints made by other members of the family showed they complained only about cooking quality and hollow heart.

TABLE 2—*Housewives' complaints about Michigan potatoes*

Type of complaints	Percent of answers	
Defects:		40
Hollow heart	10	
Rots and rotten spots	9	
Cuts and bruises	5	
Insect and diseases	5	
Streaks inside	4	
Other	7	
Cooking quality:		27
Turn dark	14	
Soggy and poor bakers	10	
Other	3	
Size and shape:		12
Not enough medium size	6	
Too small	4	
Uneven	2	
Dirtiness		8
Other faults:		13
Poor "quality" or "grade"	9	
Other	4	
Total		100

The numerous complaints concerning grade defects are somewhat surprising. They may indicate a lack of appreciation of consumer desires on the part of the retailers who offer these potatoes for sale. On the other hand, they may indicate the natural desire of consumers to buy for 55 cents as good a peck of potatoes as they can buy for 65 cents. Probably the complaints are due to a combination of both causes.

One aspect of these defects is quite important. Most of the rots, cuts and bruises were not apparent at the time of shipment. Their appearance indicates a serious decline in quality between shipper and consumer. The determination of the cause of and the remedy for this deterioration are of considerable importance to the grower, dealer and consumer.

FAVORABLE REMARKS

About one-fourth of the remarks concerning these potatoes were favorable, although only complaints were requested. Cooking quality was by far the most often mentioned favorable comment (Table 3). Only 1 percent commented on the cleanliness of the potatoes and none on the absence of grade defects. These two were often mentioned complaints. About as many mentioned the favorable size as complained about unfavorable size. This may indicate that present potato sizing pleases as many customers as it displeases. The extent of the displeasure of those who would prefer different sizing methods cannot be determined here. It is certain, however, that those who are pleased with the present mixed sizes would hesitate before paying more for uniform sizes of potatoes. The same could be said for the other

TABLE 3—*Favorable remarks concerning the bag of Michigan potatoes*

Remarks	Percent of remarks	
Cooking:		47
Cooked favorably	37	
Good flavor	10	
General:		33
Good, swell, etc	27	
Best bought for weeks, etc.	6	
Other:		20
Favorable size	8	
Firm for stored potatoes	7	
Desirable shape	5	
Total		100

TABLE 4—*Type of bag preferred by consumers*

Type of bag	Percent
Paper bag (as purchased)	57
No preference	24
Cloth mesh bag	17
Other type	2
Total	100

characteristics mentioned by a small percentage of consumers. The nine-out-of-ten consumers who did not complain of dirtiness in these potatoes might not favor paying extra for washing or brushing them.

TYPE OF BAG PREFERRED

Four-fifths of the purchasers of 15-pound paper bags either preferred this type or listed no preference (Table 4). The cloth-mesh type bag was desired by a sixth of the housewives and a bag with a window by another 2 percent. A package designed to show the potatoes appears desirable if it can be achieved at little or no increase in cost. Its importance in selling a reputable pack will be principally in affecting the first sale. Many retailers open a bag for inspection at present.

SIZE OF BAG PREFERRED

Ninety-nine percent of the purchasers of the 15-pound bag preferred this size bag or larger (Table 5). The preference for a larger bag was mostly by the families eating more than average amounts of potatoes. These families used a 15-pound bag in one week or less.

TABLE 5—*Size of bag preferred by consumers having varying rates of consumption*

Rate of family potato consumption	Size of bag preferred		
	15 lb.	Larger (percent)	Smaller
Lowest one-sixth	100	—	—
Average	81	18	1
Highest one-sixth	60	40	—

TABLE 6—*Approximate cents per peck required to move potatoes from shipping point to consumer**

Description of movement	Approximate spread from shipping point to consumer	Approximate percent of retail price
	(cents per peck)	(percent)
Central Michigan to central Michigan retailers	15.0	26
Upper peninsula to Milwaukee	15.2	32
Central Michigan to southern Michigan, North Ohio, Indiana, Illinois	18.3	34
Upper peninsula to central Michigan and Milwaukee	20.3	35
Upper peninsula to southern Michigan, North Ohio, Indiana, Illinois	28.8	44

*These charges do not include the marketing costs incurred on the potatoes prior to the time they were bagged in 15 pound bags ready for shipment.

MARKETING COSTS

The average cost of getting a 15-pound bag of potatoes from the country shipping point to the consumer ranged from as low as 15 cents for nearby sales to 29 cents for shipments from the upper peninsula to Detroit and northern Indiana, Ohio and Illinois (Table 6). This charge included transportation, wholesale distribution and retailing charges. In percentage, this distribution charge amounted to from 26 to 44 percent of the sale price of the potatoes.

DAYS POTATOES WERE IN MARKETING CHANNELS

The time for getting potatoes from the shipping point to the consumer varied from 1 to 30 days and averaged about 2 weeks. Over a week of this time was apparently spent in the retail store. A shortening of this period would seem very desirable.

SOME OBSERVATIONS BASED ON THIS STUDY

1. The price of these potatoes compared with that of other choices was the most important consideration affecting their purchase. Consumers who buy on the basis of price will not demand the same grade and quality as those to whom price is no object. The one-sixth of the families that ate one-third of the potatoes mentioned price twice as frequently as a reason for buying as the one-sixth eating the fewest potatoes.

2. The fact that the "voluntary" favorable remarks concerning these potatoes were mostly about their cooking quality emphasizes the importance of this factor.

3. Appearance of rotten spots, cuts and bruises on these potatoes between the shipper and consumer indicates a need for more facts on the reasons and places where this damage occurs. Much of this may be due to the roughness of handling and the length of the marketing period.

4. Consumers were fairly well satisfied with the present paper bags, both as to type and size. There appeared to be a considerable demand for a larger-than-15-pound container by heavy users of potatoes, especially if the price were relatively lower.

5. The length of time some of these potatoes were held in retail stores suggests the need for information on quality deterioration at store temperatures. It also suggests the need for educational work with retailers.

MASTITIS CONTROL IN THE PEN-TYPE OF DAIRY BARN

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DURING THE PAST several years dairymen who have contemplated the building of, or remodeling of their barn into, a pen-type barn have inquired about mastitis control under such an arrangement. This question is prompted by the close contact of cows during the winter season of holding cows in the barn. The milking procedure is essentially the same in the pen and tie barns; the only exception in the pen barn is that the cows are brought into the milking room in small groups (usually four) and are fed their grain while being milked. During the past 15 years we have had an opportunity of conducting mastitis studies in herds handled in pen barns. A report of these studies is presented.

HERD A

This herd was producing milk for a local market where certain studies of milk quality were being conducted. To properly evaluate the effect of management procedures on the quality of milk produced, the mastitis status of each cow in the herd was determined. On test it was found that 3 of the 15 Jersey cows of the milking herd had chronic infectious (streptococcic) mastitis. In only one of these infected cows had the owner experienced any difficulty. This cow had a few flakes in the milk and a mild swelling of the involved quarter at irregular intervals. On this account the owner decided against any immediate treatment. He did use plenty of bedding in the "loafing" part of the barn; consequently, his cattle were very clean.

Although at no time were the cattle crowded, there were two instances of "hooking" of udders by a "bossy" horned penmate during the six years of study in this herd. Dehorning of the offenders prevented further injury. A hematoma developed at each "hooked" udder; these disappeared by resorption during the following 4 and 6

ARTICLE 30-18

weeks, respectively. The injuries were cleaned and cared for daily until healed.

The owner, who also milked the cows, employed good sanitary milking procedures in his milking room. The foremilk of each cow was examined in a strip cup and the milk from any quarter producing any abnormal milk was withheld from the herd milk supply. Following the strip cup examination, each cow's udder was cleaned and disinfected with a chlorine solution (300 parts of available chlorine per 1,000,000 parts of water). In this way, the "let-down" of milk was stimulated about one minute before milking each cow. By disinfecting each udder in this way the owner's hands also were disinfected. The infected cows were always milked last. This procedure of managed milking promotes udder health. To achieve it, each cow should be milked reasonably rapidly, completely dry and at regular intervals. No spread of infection, as determined by monthly mastitis tests, occurred in this herd during a three-year period. In the author's opinion, this was due to the sanitary milking procedures used in the milking room and the sanitary environment in the loafing barn.

At the end of the 3-year period the herd numbered 20 milking cows, owing to the addition of seven first-calf heifers and the disposal for slaughter of two cows that were non-profitable because of very low production in one case and breeding difficulty in the other case.

The three mastitis-infected cows were treated by udder infusion; none of the three had any marked indurations in their udders. Although they were infected for at least 3 years, two cows became free of infection following one administration of 150 mgm. of tyrothricin per quarter while the third cow required three such infusions to destroy the infection. The herd was under study for one more year before dispersal and remained free from udder infection. Several minor udder traumatisms accounted for two cases of non-infectious mastitis during this period.

HERD B

This herd of 12 Holstein cows presented itself for study when the local veterinarian called for consultation on the almost continuous mastitis affecting the cows of the herd. The history revealed that one or two cases of clinical or acute mastitis were present at all times during the previous four months which marks the time the cattle were kept in a remodeled pen-type barn. Varying amounts of scar tissue

were found in the udders of this herd indicating either previous trauma or infection.

The cattle were not crowded in the "loafing" part of the barn, but when they were brought into the milking room for sampling and for physical examinations of the udder, the cows, and especially their udders, were very dirty with manure. Examination revealed that very little straw was used for bedding and the amount used was soon trampled into the manure under foot. Reasonably good milking procedures were used.

Three cows, in one quarter each, were producing abnormal milk in quarters that were acutely inflamed. None of these cows showed any systemic disturbances. Bacteriological tests revealed the cause of the acute mastitis to be *Escherichia coli;* in addition two cases of chronic streptococcic mastitis were located. The *Esch. coli* or coliform organism as it is sometimes called is a normal inhabitant of the intestinal tract and, therefore, is in the environment of every cow. One can understand that if the cow is allowed to lie down in its own dirt the opportunities for entry of this germ into the udder are facilitated.

The owner was instructed to curry his cows thoroughly and to use an abundance of straw to bed the animals. The udder infections were treated by giving two 100-cc. quantities of a solution consisting of 2½-percent sodium sulfapyridine, 2½-percent sodium sulfathiazole in 5-percent dextrose per infected quarter at 24-hour intervals. The condition of the quarters improved steadily so that after 4 days the milk produced by them was normal and the swelling was practically gone.

Following the time that the animals were given plenty of bedding, their udders and bodies remained free from manure and no new cases of coliform mastitis developed during the subsequent 6-month period that monthly mastitis tests were made.

HERD C

Mastitis tests revealed that 4 of the 28 mixed breed dairy cows of this herd had chronic streptococcic mastitis. These were immediately eliminated for slaughter, because the owner preferred to eradicate the disease in this way.

A plentiful amount of straw was used to bed the "loafing" shed at all times. A second-hand milking machine was used to milk the cows in the milking room. The vacuum pump was not manufactured

by the same company as had made the milking machine, although everything seemed to be operating properly with a reading of approximately 14 on the vacuum gage. The cows were always checked to be sure that all milk had been obtained at each milking.

In spite of the sanitary operation of the machine, under the foregoing conditions six cows of the herd were frequently affected with slightly swollen quarters that gave "flakey" milk. During the previous 3 months all but five cows were so affected at least once. Since the management and sanitary procedures practiced were beyond criticism, a new and tested vacuum gage was installed. To the author's amazement, it registered 19 during the operation of the milking machine. A mechanic immediately adjusted the pump to operate at 15 inches of vacuum. This was the only change made on the farm but it solved the mastitis problem. Only one animal gave flakes in the milk during the subsequent period of 6 months, and it was known that she had slipped and fallen in the barn. Apparently her udder had been bruised during the fall.

The experience in this herd demonstrates that a herd free from udder infection may not be free from mastitis (due to non-infectious agents). It is necessary to overcome or control the non-infectious as well as the infectious factors that cause mastitis to eradicate or keep mastitis at a minimum.

SUMMARY

The application of the principles of good milking and herd management, together with the essential veterinary service for diagnosis and treatment, makes possible the control of mastitis in herds kept in pen-type barns.

LOSS OF PRESSURE BY DIFFUSION IN TRACTOR TIRE TUBES

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THE *Michigan Agricultural Experiment Station Quarterly Bulletin*, Volume 28, Number 1 for August 1945, carries an article entitled, "Studies on Use of Liquid in Tractor Tires." Results of the study of loss of pressure by diffusion in air-filled or partially air-filled tires as found in this article indicated considerable loss of air pressure through the pores of the tubes.

The tire tubes used in these tests were known as G. R. S. 3 synthetics. Since that time, butyl synthetic tubes were substituted by the industry as a whole. These butyl tubes were advertised as being superior to the G. R. S. 3 synthetics, with reference to air diffusion.

Accordingly, tests were conducted comparing two 10-38 tractor tires at the initial tire pressure of 12 pounds per square inch at 60° F. One tire contained a new G. R. S. 3 synthetic tube and the other a butyl synthetic tube.

Accurate pressure gages were attached to the valve stems of each tire tube. Pressure readings were taken daily with the result that at the end of 84 days, there was no measurable drop in pressure for the butyl synthetic tube, whereas the G. R. S. 3 synthetic tube recorded a drop in pressure from 12 pounds per square inch to 8.3 pounds per square inch.

This fact should be recognized in an interpretation of the results as found in the above-mentioned article, since butyl synthetic tubes are now generally supplied by the tire industry.

ARTICLE 30-19

EFFECTS OF DIETS CONTAINING FOODS WITH POSSIBLE ANTIBIOTIC PROPERTIES ON THE GROWTH AND DEVELOPMENT OF WHITE RATS

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MAN HAS SOUGHT CURES for his ailments in the plant life around him from time immemorial. The herb doctor of medieval ages was regarded highly, and our grandmothers kept herb gardens in the interest of the family's health. Several modern drugs have been isolated from plant tissue, and, although the former faith in many of the remedies has been discredited, unexplained curative powers also have been demonstrated.

The possible connection of epidemic diseases to season and to the foods generally available seasonally should not be overlooked. Goldberger (6) and Spies (31) have demonstrated this relationship to pellagra in the southern states.

The use of food in improving the health of populations has progressed rapidly with the knowledge of the structure of the proteins and vitamins and the function of these and other compounds found in food. A casual survey of the literature makes it clear that many unidentified food factors exist. It is possible that certain of these factors may be important in the control of infections. Feeding trials of materials of suspected antibiotic potency are pertinent, therefore, in order to determine the effect on growth and function as well as resistance to infection. The former is the purpose of these studies.

EXPERIMENTAL PROCEDURES

Litter mate, weanling, albino rats from the same stock (Wistar strain), weighing an average of 55 grams, were placed in individual screen bottom cages, and given a semi-synthetic diet and tap water *ad libitum*. Five males and five females were used for each experimental garlic diet and a total of six males and six females maintained

ARTICLE 30-20

TABLE 1—*Composition of the experimental diets*

Diet	Cereal substance	Ingredients					
		Casein	Yeast	Salt mixture	Corn* oil	Cod-liver oil	Garlic
	gm.	gm	gm.	gm.	gm.	gm.	gm.
Control I	Cornstarch 64.0	18.0	8.0	4.0	5.0	1.0	
2.5% Garlic	Cornstarch 61.5	18.0	8.0	4.0	5.0	1.0	2.5
5.0% Garlic	Cornstarch 59.0	18.0	8.0	4.0	5.0	1.0	5.0
Control II	Cornstarch 64.0	20.0	6.0	3.0	6.0	1.0	
Barley	Whole ground barley 76.0	11.0	4.0	3.0	5.0	1.0	
Corn	Whole ground corn 72.0	15.0	4.0	3.0	5.0	1.0	

*Wesson (38).

as controls. There were four males and four females fed each of the grain diets and the comparable control diets. The composition of the diets is shown in Table 1. The control diets used in this study were semi-synthetic. While they contained all known requirements for rat growth, it was hoped that optimal reproductive performance would not be obtained so that either accelerating or depressing effects of the test foods could be measured.

Incorporated with the diet just before feeding, was 2.5 and 5 percent of dehydrated garlic,[1] prepared from mature cloves. These quantities were equivalent to 10 and 20 percent of fresh garlic. Grains used in the diets were Michigan barley, test weight 46 to 48 pounds to a bushel, and No. 2 yellow corn. These were purchased in quantity by the College for stock and poultry feed. After grinding, the grains

TABLE 2—*Weight gains and utilization of food by first-generation animals*

Sex	Group	Number of animals	Mean weight			
			At weaning	Gained in 200 days	Of young reared	Of tissue produced/gm. food eaten
			gm.	gm.	gm.	gm.
Male	Control	6	52	392	....	.111
	2.5% Garlic	5	61	335	....	.107
	5.0% Garlic	5	55	308	....	.099
Female	Control	6	55	195	365	.155
	2.5% Garlic	5	54	204	165	.122
	5.0% Garlic	5	53	175	302	.153

[1]Prepared by the Basic Vegetable Products Company, Vacaville, California.

TABLE 3—*Weight gains of second-generation animals*

Group	Mean weight			
	At weaning		Gain in 287 days*	
	Male	Female	Male	Female
	gm.	gm.	gm.	gm.
Control	59	57	227	197
2.5% Garlic	52	50	209	186
5.0% Garlic	50	48	221	195

*Mean length of life. All were mated until young were produced or until it was evident they were sterile.

were sifted through a coarse sieve to remove husks and bits of cob, and ground again to pass a small mesh kitchen sieve. Each set of experimental diets was calculated to contain comparable amounts of the known nutrients.

The animals were weighed weekly, and food consumption and weight gains are recorded in Tables 2 and 7.

Examinations of the bloods were made when the rats had been fed the diets for 4 weeks, and at 30-day intervals thereafter for a total of 6 months. Blood from a tail clip was collected in a paraffin cup containing heparin. All sampling was done in duplicate by two of the authors[2] at approximately the same time of day. Hemoglobin was determined by the method of Sheard and Sanford as adapted for use in the photo-electric colorimeter (11). Blood for the red cell counts was taken in certified Thoma pipettes and diluted with Hayem's solution. The pipettes were shaken for 3 minutes and sampled in certified Neubauer Improved Hemacytometers. Chambers were checked for uneven distribution and eliminated before counting if irregularities of filling were evident. The average value of four chambers was recorded as the cell count.

When the animals were 4 months old, brother and sister rats on the same diet were mated. Males were left with the females for 10 days, then the females were bedded on wood shavings until the young were weaned. Females were remated one week after removal of the first litter of young. First litters were discarded.

Representative second-litter, second-generation rats were placed on the parental diets at weaning, and brother and sister rats mated at maturity. After the second litters were weaned, the parent animals

[2]A. C. J. and R. M. N.

were sacrificed and complete gross autopsies were performed. When the second-generation animals had reared their young, or when it was evident that they were sterile, they were sacrificed and autopsied.

GARLIC

For centuries medicinal properties have been attributed to plants of the botanical genus "Allium." Recently workers report curative powers of garlic or onion in isolated cases of dyspepsia, gastro-enteritis, and celiac disease (19, 24), diabetes (18), typhoid fever (20), and tuberculosis (20). A controversy flared briefly over the control of arterial hypertension with a garlic extract, "allisatin" (22, 28, 33). Frenkel and Lewitzkaja (4) found that 3 percent of garlic in a diet caused a significant reduction in intestinal putrefaction in rats, and several workers record the bactericidal effects of the juice, vapors, and extracts of garlic (12, 37), and onions (5, 16, 23, and 36). Carl and his co-workers found that a diet containing 20 or 30 percent of raw garlic would kill adult rats in 3 to 11 days, but they did not describe the pathological changes which occurred (2). "Onion poisoning" and anemia have been reported in cattle (7), dogs (10, 26, 27), and horses (35) but the effects on the blood picture have not been noted after feeding garlic.

This study was undertaken to determine the effects of the ingestion of large quantities of garlic on the blood formation, growth, and reproduction of white rats.

Results

It will be noted in Table 2 that male rats fed the control diet made the best total growth, but also ate the most food. Those fed 2.5 percent garlic gained more than those fed 5.0 percent garlic although food intake was the same.

Since the female rats were allowed to reproduce, the weight of the litters at weaning was calculated as tissue produced. All females produced more tissue per gram of food consumed than the males. Seemingly, 2.5 percent of dry garlic permitted the least tissue growth as the young of this group were lighter in weight at weaning.

Although the mean trend of hemoglobin values in male and female rats fed these diets was higher when no garlic was fed and progressively lower as the concentration of garlic increased, these differences were found to be insignificant when the "t" test was used to compare the groups. Erythrocyte counts for the animals followed the same

TABLE 4—*Hemoglobin concentrations and erythrocyte counts for rats of the first-generation on the experimental diets*

Sex	Group	Hemoglobin grams/100 ml.		Erythrocytes million/c.m.m.	
		Mean	S.D.	Mean	S.D.
Male	Control	15.66	.593	8.94	.342
	2.5% Garlic	15.09	.614	8.81	.570
	5.0% Garlic	14.39	.336	8.44	.552
Female	Control	15.44	1.36	8.53	.497
	2.5% Garlic	14.63	1.11	8.01	.490
	5.0% Garlic	14.03	.841	7.76	.790

pattern as the hemoglobin values, but again differences were insignificant. Garlic powder in the dietary of albino rats equivalent to 10 and 20 percent of the fresh bulb appears to have little effect on erythropoiesis. All the values were within the ranges reported by Donaldson (3) and by Reich and Dunning (25).

A summary of the reproductive performance of the stock colony for a 10-year period is included with the data for the experimental animals in Table 5. Although the females fed the control diet produced as many young per animal as stock colony females, only 42 percent of them were reared. Garlic-fed rats bore fewer young, but reared more of them, comparing well in this respect with the stock animals. The rats fed 2.5 percent of garlic showed the best results for the number and percentage of young reared, but the young weighed

TABLE 5—*Reproductive performance of two generations of rats fed the experimental diets*

Group	Generation	Litter number	Number of females		Young		
			Mated	Bearing litters	Total born	Percent reared	Mean weight at 28 days (gm.)
						%	
Control	1	2	6	6	50	42.0	46.2
	2	1	6	2	8	25.0	62.0
2.5% Garlic	1	2	5	5	30	73.3	42.0
	2	1	5	3	14	72.0	44.3
5.0% Garlic	1	2	5	5	33	63.6	45.1
	2	1	4	0			
Stock						66.1	51.0

TABLE 6—*The incidence of lung lesions in two generations of rats as revealed by gross autopsy*

Sex	Group	Lungs	
		Normal	Abnormal
		Number of rats	Number of rats
Male	Control I	6	5
	2.5% Garlic	5	5
	5.0% Garlic	5	4
	Stock	3	14
Female	Control I	7	5
	2.5% Garlic	5	6
	5.0% Garlic	3	6
	Stock	12	57

less at weaning. All young in the experimental groups weighed less at weaning than did the young of the stock colony rats, even though fewer young were reared by each female.

Greenwood (8) reports that stock animals reared 73.6 percent of their litters to a weaning weight of 48.8 grams (28 days of age). Slonaker (29) fed a diet containing an amount of protein similar to that of these studies to female rats who reared 60.3 percent of the young, with a weaning weight at 25 days of 27.5 grams.

The second-litter young were fed the parent's diet after weaning and brothers and sisters mated when 6 months old. Only one-third of these matings were successful, although the rats were given additional alphatocopherol and those males and females who failed to intermate were mated with stock animals of known fertility. Fewer young were born to second-generation females on all diets than to the parent animals, but the females fed 2.5 percent of garlic reared the same percentage of their young as the parents. These young weighed less than the young of the control group. The 5-percent garlic diet failed to support reproduction in a second generation of albino rats.

Careful autopsy revealed the lung congestion common to laboratory rats in 42, 40 and 50 percent of the control, 2.5-percent garlic, and 5.0-percent garlic diet animals (first generation), respectively, and in 45. 64 and 63 percent of their young, respectively. The lesions varied from a red, congested appearance to nodules of caseous material. Parent male animals were more severely affected than the females, but the reverse was true of their young. Slightly more males were affected in the stock colony. This agrees with the data of

Slonaker (30) who found that the male rats in his studies were more susceptible than the females. Since this lung condition is known to involve a secondary invasion of bacteria, garlic did not exert an anti-biotic effect under the conditions fed.

Summary—Garlic

A powder made from whole garlic cloves was incorporated into a semi-synthetic diet for albino rats, and its effect on growth, reproduction, and the formed elements of the blood was observed.

Although garlic caused a slight depression in the growth of male rats, the addition of 5 percent dry garlic to the diet of female rats permitted the production of more tissue than did the addition of 2.5 percent of dry garlic. The offspring of rats fed 5 percent of dry garlic powder were sterile.

There was a slight but not significant depression in hemoglobin concentrations and erythrocyte counts when garlic was fed. However, the values for garlic-fed rats are within the range reported by other workers.

Female rats of both generations fed 2.5 percent of garlic reared the largest number and percentage of their young, but the weight of the young at weaning was less than in the other groups. The weaning weights of the young of females on all three diets were lower than those of the young of stock colony females. Thus the control diet proved to be a valid one against which both decreased and increased growth performance could be measured.

The ingestion of garlic did not inhibit a chronic lung congestion in these animals, and its incidence was increased in the second generation of garlic-fed animals.

BARLEY AND CORN

There are no references in the literature to support the assumption that barley has anti-biotic properties, but because of the persistence in folk-lore of the use of barley-water for intestinal upsets in infants (21), and studies of its superiority as a ration for laying chickens (14 and 34) and for rats (32), and, as pearled barley in treating spontaneous breast cancer in mice (15), barley warrants further study.

Corn and cornstarch are the chief sources of carbohydrate in the diet used for stock rats in this laboratory. Because of reproductive

failure and the high incidence of a lung congestion encountered in stock animals, this portion of the experiment was designed to study the influence of substituting barley for corn in a semi-synthetic ration.

Results

All animals grew well on the grain diets, had smooth, glossy coats, and were active throughout the experiment. The corn-fed animals were plumper and less active than the barley-fed rats. Barley-fed male rats made the least gain for each gram of food consumed, but it was noted that feces was more bulky on the barley diet and contained much visible fiber. It is possible that the laxative effect of the fiber prevented the ultimate utilization of the diet, since the caloric value of the diets was comparable. One male rat died after consuming the barley diet for 3 days, and routine autopsy disclosed an intestinal obstruction of fibrous material.

The male control rats gained the most weight per gram of available protein and corn rats the least.

From Table 7 it will be noted that barley-fed females produced more tissue per gram of food eaten and also per gram of protein than either those fed corn or the control rats.

The calculated nutrient values of the diets are comparable. The daily intake of essential amino acids was calculated from data compiled by Block and Bolling (1). Although the barley-fed rats, by consuming more diet, had a higher total protein intake, in the amounts

TABLE 7—*Weight gains and utilization of food by first-generation animals*

Sex	Group	Number of animals	Mean weight				
			At weaning	Gained in 200 days	Of young reared	Of tissue produced/ gm. food eaten	Of tissue produced/ gm. protein eaten
			gm.	gm.	gm.	gm.	gm.
Male	Control	4	61	423	....	.113	.504
	Barley*	4	64	373	....	.091	.369
	Corn	3	74	437	....	.115	.271
Female	Control	4	56	195	237	.115	.515
	Barley	4	60	197	601	.170	.698
	Corn	4	59	200	214	.108	.562

*One died with an intestinal obstruction after 3 days on the diet.

TABLE 8—*Weight gains of second-litter, second-generation animals*

Group	Number of animals		Mean weight			
			At weaning		Gained in 150 days	
	Male	Female	Male	Female	Male	Female
			gm.	gm.	gm.	gm.
Control	11	5	50	47	310	344
Barley	14	13	51	48	273	163
Corn	9	3	70	54	348	193

eaten, the three diets furnished similar quantities of arginine, methionine, tryptophane and valine. The barley diet furnished less isoleucine, leucine, lysine and threonine than the control or corn diets and more histidine and phenylalanine. All three diets supplied the essential amino acids in excess of the amounts recommended by Griffith and Farris (9). Barley-fed females excelled in reproductive performance and it might be of interest to explore further the apparent superiority of the diet in this respect.

Autopsy revealed moderate fat deposits in the bodies of the control animals. The corn-fed rats were in excellent condition but had large accumulations of fat in the abdomen. The barley-fed animals had a minimal amount of fat, but had a well developed musculature.

Table 9 records the hemoglobin concentrations and red cell counts of these animals. There were no significant differences between groups. The mean erythrocyte counts for both male and female animals fed barley were slightly higher than those fed corn or control diets. All were superior to rats of the same strain at the same period in the life span as reported by Donaldson (3).

TABLE 9—*Hemoglobin determinations and erythrocyte counts for rats of the first-generation on the experimental diets*

Sex	Group	Hemoglobin gm./100 ml. of blood		Erythrocytes million/c.m.m. of blood	
		Mean	S.D.	Mean	S.D.
Male	Control II	15.7	.672	7.9	.625
	Barley	15.8	.501	8.22	.698
	Corn	15.6	.444	7.79	.476
Female	Control II	15.4	.70	8.62	.520
	Barley	15.7	.733	8.77	.450
	Corn	15.4	1.1	8.70	.955

TABLE 10—*Reproductive performance of two generations of rats*

Group	Generation	Litter number	Number of females		Young		
			Mated	Bearing litters	Total born	Percent reared	Mean weight at 28 days
							gm.
Control	1	1	4	3	27	11.1	51.3
	1	2	4	3	22	72.7	49.5
	2	1	4	3	17	70.5	45.4
Barley	1	1	4	4	29	75.8	48.4
	1	2	4	4	36	75.0	49.6
	2	1	13	7	56	61.0	48.3
Corn	1	1	4	4	32	3.1	65.0
	1	2	4	3	29	41.3	66.0
	2	1	3	2	14	21.4	52.0

The hemoglobin values and erythrocyte counts for all of these rats compare favorably with the results of studies made by Reich and Dunning (25) on rats of other strains. For the period of 28 to 200 days of age in over 2,000 rats, they found an average value of 13.6 gm. of hemoglobin per 100 ml. of blood, and 7.9 million erythrocytes for each cubic millimeter of blood. It is concluded that feeding barley and corn has little effect on blood formation.

Data for the first and second litters of the parent animals are presented in Table 10. More young were born to and reared by the barley-fed females than by females fed either of the other diets. Barley-fed females outranked stock females also in the number and percentage of young reared. Slonaker (29) reports a mean of 4.3 young born per female, and 60.3 percent of these young weaned at a comparable protein intake. Macomber (17) found that females fed 20.8 percent protein were able to rear 93 percent of their young.

The weight at weaning of young from barley-fed animals was comparable with stock young when the number reared is considered. Young from corn-fed animals attained more weight proportionately than any of the other young.

The sex ratio of the young is interesting. The ratio of males to females of barley young is 1: 1, corn 2: 1, and control 3: 1. As the sex of the newborn was not determined it is not known if this is a matter of survival. On the same protein intake, Slonaker (29) found a 1: 1 ratio to exist, and King (13) reports 107.3 males to 100 females. The latter author assumes that the animal in prime condition pro-

duces a litter of 1: 1 ratio or nearly that, and that an excess of male young are born to females either before or after their reproductive prime or when they are in poor physical condition.

Cannibalism caused the deaths of 70 percent of the total young born to corn-fed animals, 40 percent of the control young, and 18 percent of the young in the barley-fed group. Since the diets contained comparable amounts of protein, and since all but barley contained 14 percent or more of casein, cannibalism cannot be attributed to a lack of protein.

Two of the control females and one of the females fed corn failed to bear two litters. There was evidence of resorption in the corn fed and in one of the control females.

As with the parent animals, more young were born to, and reared by, the barley-fed young than by the second generation of either of the other dietary groups. The corn young attained the greatest weight, owing probably to the smaller litters.

The incidence of the chronic rat lung congestion was higher in the barley-fed animals than in either of the other groups. In both parents and young an equal number of males and females were affected, but at autopsy it was noted that females were more severely affected. This was true only of the barley-fed rats, and more males than females of the other two groups were affected.

TABLE 11—*Incidence of lung lesions in two generations of rats as revealed by gross autopsy*

Sex	Group	Lungs: Normal — Number of rats	Lungs: Abnormal — Number of rats
Male	Control II	10	6
	Barley	4	13
	Corn	7	2
	Stock	3	14
Female	Control II	7	1
	Barley	4	12
	Corn	7	0
	Stock	12	57

Summary—Barley and Corn

Neither barley nor corn affected the blood picture when these grains were the chief ingredient of rat dietaries.

Barley feeding resulted in a better reproductive performance than corn. A greater percentage of the young born were reared in both the first and the second generation.

Corn protected the rat from a chronic lung congestion to a greater extent than barley. The majority of corn-fed rats exhibited no lesions, while the majority of the barley-fed animals were affected.

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A METHOD OF ESTIMATING WHETHER HAY OR GRAIN WILL KEEP IN STORAGE

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SECTION OF FARM CROPS

THE ORGANISMS of decay, mostly molds or other microscopic organisms, are present in large numbers on the surfaces of practically all hays and grains which are harvested and stored for future use. In their inactive state they are harmless, but their growth causes heating, mustiness and molding. As long as the air surrounding the kernels of grain or the stems of hay remains relatively dry, these organisms remain inactive. However, when this air has a relative humidity of about 80-85 percent, the spores germinate readily (1) (5), just as crop seeds remain dormant in dry soil but sprout if the soil is damp.

It has been shown (2) (3) that, in a closed container, the relative humidity of the atmosphere is determined by the moisture content of the enclosed hay or grain. That is, the air in a bin of dry grain is relatively dry; in a bin of damp grain, relatively damp. Any particular sample of grain or hay is capable of maintaining only one certain *definite* relative humidity, in equilibrium with the surrounding atmosphere. For example, a one-pound or a one-ounce sample of wheat that contains 10 percent of water will maintain a relative humidity of about 45 to 50 percent and cannot maintain a relative humidity of 75 percent or more in a sealed quart jar. Yet two or three drops of pure water in the otherwise empty jar will maintain a relative humidity of 100 percent. Evidently water in hay or grain and water as we ordinarily see it behave quite differently.

Loose hay dry enough to go into a barn where there is an ordinary amount of ventilation contains, usually, about 25 percent of water by weight; straw 18 percent. Wheat, oats or barley when dry enough to store contains about 14 to 15 percent moisture. At these moisture contents, these materials will all maintain a relative humidity of about 80-85 percent in a closed container. Although the ventilation in a farmer's mow or bin is ordinarily sufficient to keep them from spoiling

ARTICLE 30-21

they might spoil in almost airtight storage, or if stored in great quantities, or in a tightly-packed condition (baled hay).

If hay and grains are to keep in storage, then, the atmosphere surrounding them must not remain at a relative humidity as high as 80-85 percent for any great length of time. Even two or three days at this humidity is sufficient for serious molding at summer temperatures.

In the method described below, we determine *whether the sample can maintain a dangerous relative humidity in a closed container,* and thus accurately estimate its keeping quality in ordinary farm storage.

HOW TO DETECT A RELATIVE HUMIDITY OF 75-80 PERCENT

It is well known that common table salt becomes moist and sticky when the surrounding air is very damp — that is, when the relative humidity is high. But *pure* salt does not absorb moisture from the air *unless the relative humidity is above 75 percent.* There are other chemical compounds, of course, that require still higher relative humidities before they will absorb water-vapor; others will become damp at far lower relative humidities — such as calcium chloride, which is used to "lay the dust" on our dirt roads. A word of warning should be given. Whether a chemical will become damp frequently depends upon small traces of impurities (such as calcium chloride) which take up water very readily, causing the entire material to become damp.

Three pure salts, sodium chloride, ammonium chloride and ammonium sulfate have been used successfully in this determination. According to the chemical handbooks (4) a saturated solution of sodium chloride will evaporate to dryness at a relative humidity of less than 75-76 percent—or conversely, the dry (pure) salt will become damp if the relative humidity is higher than this figure. For ammonium chloride or sulfate, the corresponding figure is 79-81 percent R.H. Common table salt (sodium chloride), with added phosfate to inactivate calcium and magnesium salts, may be used. A fine-grained is preferable to and more sensitive than a coarse-grained salt. On this point further research is necessary. For most purposes, ammonium chloride seems preferable because it is usually purified before it reaches the consumer. Or pure—not fertilizer grade—ammonium sulfate may be used. These materials are all relatively inexpensive, even in suitably purified form.

The type of container used is important. A wax-impregnated cardboard container—an ice-cream carton, for example—seems the most satisfactory. A half-pint or smaller (for grains) and a quart (for hays) are suitable. Glass containers are unsatisfactory, first, because the surface of the glass becomes sticky at high relative humidities, and second, because the test must be performed in the shade—without the sun furnishing energy to evaporate water or change temperatures. Ordinary untreated wooden or paper containers are unsatisfactory, since they absorb the water vapor intended for the salts. Ordinary unlined metal containers tend to vary in temperature on handling, and are best avoided for various other reasons.

PROCEDURE FOR HAY

To make the test for keeping quality, proceed as follows:

1. Obtain a good, fair sample. A sample of hay should consist of several lots, so as to represent all of the hay. It is best to try to avoid badly mixed samples that contain partly very green and partly very dry hay. No one is able to duplicate such samples, or make them representative. Try, rather, to get reasonably uniform samples that represent an average condition of the hay. It is difficult, at best, to obtain a good, fair sample.

2. Bend or twist the composite sample to break the stems.

3. Grasp as large a handful as you can comfortably hold, and from the center cut a portion approximately as long as your (quart) container.

4. Place the sample in the container and add a spoonful of salt. The sample should not fit so snugly as to prevent free circulation of the added salt. Shake about 100 times, to keep the salt and hay moving about.

5. Place the container cover down and shake the salt into the cover, or down to the lower end of the container, where the salt can be examined. There is no difficulty in recognizing the damp salt which gathers in clumps rather than remaining in single grains.

6. If the salt seems on the borderline, place in the box and shake again and let stand for a few minutes. Samples that are distinctly too wet change the salt from dry to moist in perhaps 30 seconds.

Borderline cases may take 1 or 2 minutes before the salt becomes slightly moist. Samples that are somewhat drier than they need be for safe storage will never raise the humidity in the carton high enough so that the salt becomes damp. After a little experience, any operator will be able to detect samples that are almost but not quite dry enough to store.

PROCEDURE FOR GRAIN

Thresh out about 10 representative heads of grain. Place in a small container with about one-half spoonful of salt. Shake about 50 times. The test appears to be more rapid with oats, wheat or barley than with hays. Repeat the shaking in doubtful cases.

Table 1 presents the results from tests with ammonium chloride

TABLE 1—*Moisture contents of samples of grains and hay at which sodium chloride and ammonium chloride did or did not take up moisture.*

	Took up moisture and became sticky	Borderline	Stayed dry and fine
Ammonium chloride			
Oats	24.2	14.2	13.3
Oats	22.6	15.0	13.7
Oats	17.6		13.4
Oats	23.1		13.1
Oats	16.1		
Oats	17.9		
Oats	18.2		
Oats	16.5		
Oats	17.6		
Oats	16.0		
Barley	24.7		13.6
Barley			12.1
Wheat			13.8
Wheat			12.1
Rye			13.3
Rye			10.8
Mixed alfalfa and grass	33.8	24.5	20.1
Mixed alfalfa and grass	28.1	24.0	24.5
Timothy			24.5
Smooth brome			21.1
Alfalfa	30.0	24.8	23.5
Reed canary			24.5
Sweet clover	35.5		
Red clover			21.0
Oat straw	25.0		
Sodium chloride			
Oats	16.1	14.2	13.0
Oats	17.6		
Oats	16.5		
Mixed alfalfa and grass	31.5	25.5	19.1
Mixed alfalfa and grass	39.0		22.2
Timothy			25.0
Smooth brome			19.1
Alfalfa	29.9		21.5
Sweet clover	35.3		
Red clover			24.0
Oat straw		25.6	

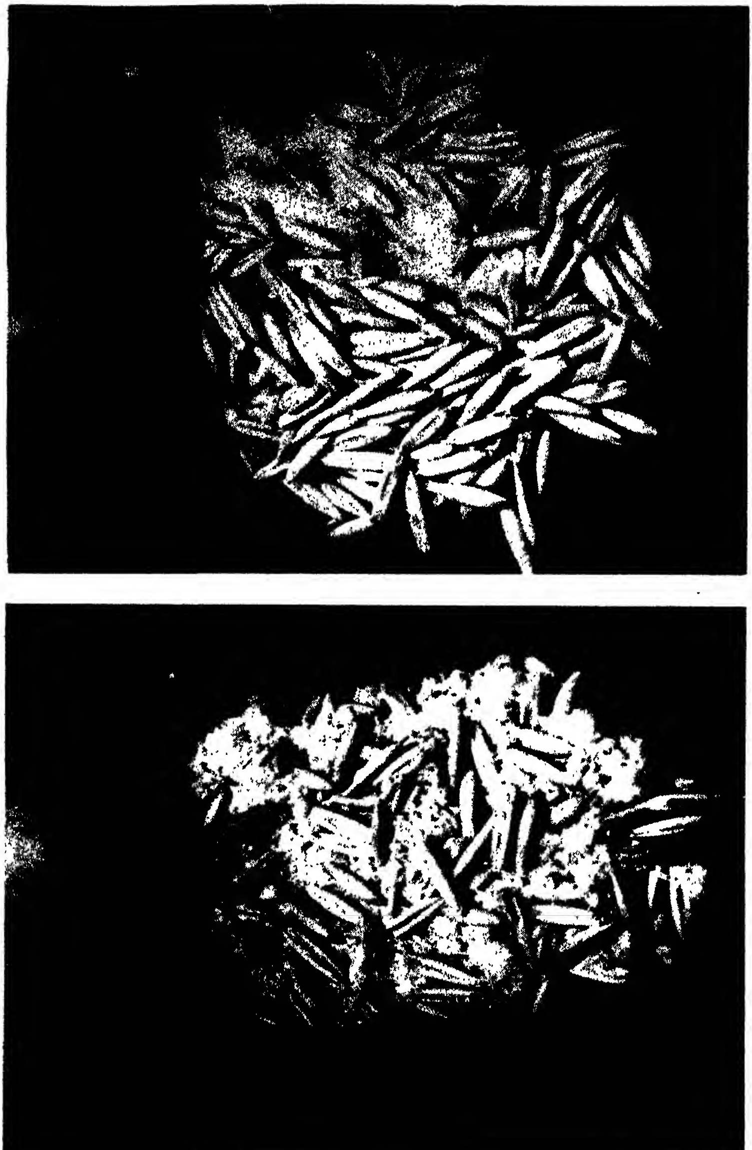

Fig. 1. The photographs show the condition of ammonium chloride after being shaken 50 times in a closed container with oats that were dry enough to store (upper) and with oats that were slightly too damp to store (lower). The containers were emptied onto a black cloth for photographing.

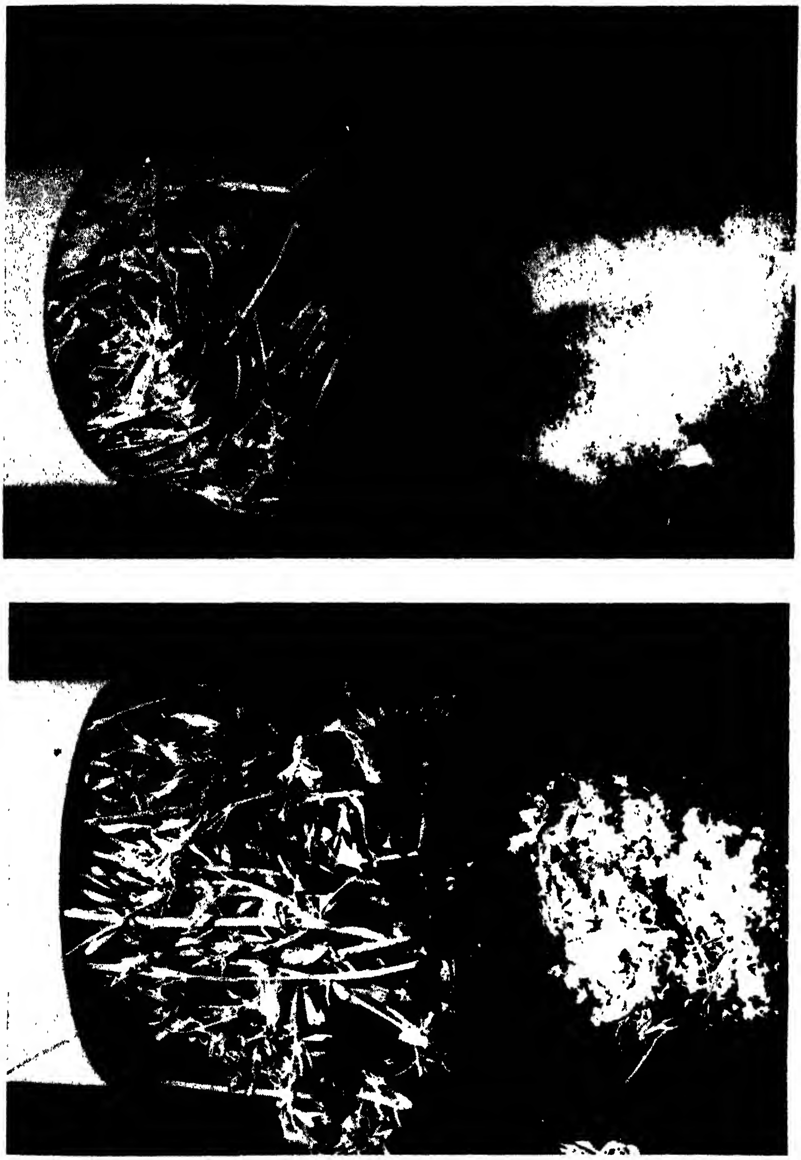

Fig. 2. The photographs show the condition of ammonium chloride after being shaken 100 times in a closed container with hay that was dry enough to store (upper) and with hay that was too damp to store (lower). The containers were emptied onto a black cloth for photographing.

and with *sodium chloride*. Results with ammonium sulfate were almost identical and are omitted. Figures 1 and 2 show photographs of typical tests.

DISCUSSION

From the results given in Table 1 and from further experience in the field, there is some suggestion that ammonium chloride absorbed water fully as readily as did sodium chloride. Reasoning from clear-cut data concerning saturated solutions, one would believe that this should not be the case. It might be expected that ammonium chloride would become slightly damp only with samples that gave a relative humidity abundantly high to cause dampness in sodium chloride. The reverse seems more likely. Perhaps the answer to this problem is a consideration of the relative heats of solution of the two compounds, or possibly in their relative hydrolysis. The heat of solution of ammonium chloride is negative, thus possibly causing slight cooling at the surface of the crystals and excess condensation, while that of sodium chloride is positive, which might lead to slight heating and reduced condensation. Further experimentation with suitable mixtures may explain this seeming discrepancy and give a still more useful reagent and more precise recommendations.

In all of this testing, two things are essential. First of all, the chemists tell us, "*No analysis is better than the sample.*" From a poor, unrepresentative sample, a poor, unreliable judgment must result. A second point is the consideration of the type of storage. Hay or grain stored rapidly and in great bulk in a tight storage, needs to be drier than such products stored where moderate ventilation can assist in lowering the relative humidity in the mow or bin.

Without good judgment on these two points, no test, no matter how accurate or detailed, can assure good keeping quality in stored products. Routine utilization of this test should completely eliminate poor judgment as when to bale hay, combine oats, etc., and should make good judgment better.

SUMMARY

The keeping quality of a hay or grain is determined by the relative humidity of the interstitial atmosphere. To test this relative humidity, various chemical compounds may be used which will absorb moisture from the atmosphere when the relative humidity exceeds various

critical values. A saturated solution of sodium chloride will maintain a relative humidity of 75-76 percent in a closed container, and one of ammonium chloride or ammonium sulfate 79-81 percent. These dry salts when shaken up with samples of hay or grain will become damp if the hay or grain is too moist for safe storage, but will remain dry if the products are sufficiently cured.

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A METHOD FOR RAPIDLY DETERMINING THE MOISTURE CONTENT OF HAY OR GRAIN

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SECTION OF FARM CROPS

EVEN THE MOST experienced farmer or agronomist concedes the difficulty in accurately estimating the moisture content of partially dried hay. The burned barns, the moldy bales and the malodorous silage add further evidence to the point.

An accompanying publication (1) indicates how a farmer can quickly tell whether his hay or grain is ready to go into ordinary storage. But frequently we wish to know more than that. We wish to know in percentage the moisture content of the product. The following description will show how to obtain this figure simply, quickly, inexpensively and accurately.

To make this determination, use is made of the fact that from the exhaust pipe of a car or tractor there issues a blast of hot air, the temperature of which may be controlled by the throttle.

EQUIPMENT NEEDED

On the end of the exhaust pipe is attached a round "muffler" – simply a larger metal tube, about 4 or 5 inches in diameter and 10 or 12 inches long. This chamber constitutes the "oven" in which the water may be evaporated. Figure 1 gives a diagram of the construction of a simple oven.

To hold the sample of hay, the following device is recommended. Remove the ends from a large can, and cut the side completely through to give a rectangle of sheet metal, rolled into a cylinder. This can should be somewhat larger in diameter than the oven.

One other piece of equipment is needed, namely a spring scales reading in grams, and with an adjustable face. A thermometer reading to 140° C. (300° F.) is desirable. Figure 2 is a photograph of these four pieces of equipment. Gloves are helpful in handling the hot cylinder.

ARTICLE 30-22

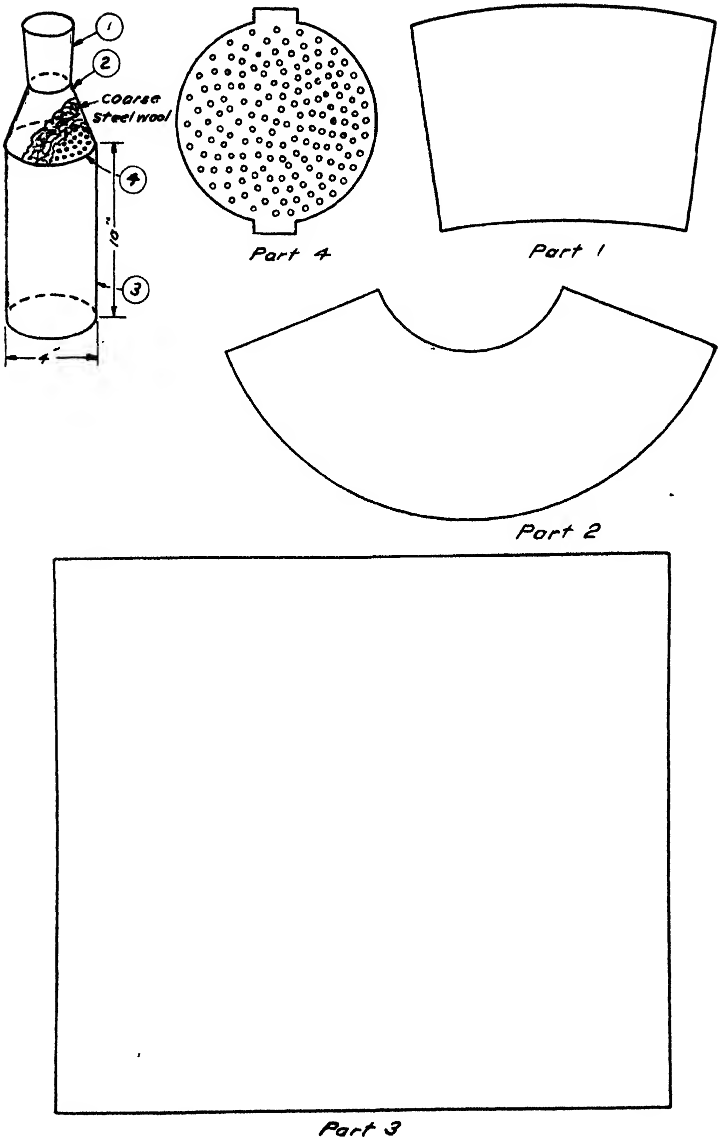

Fig. 1. Diagram of the construction of a simple sheet-metal oven.

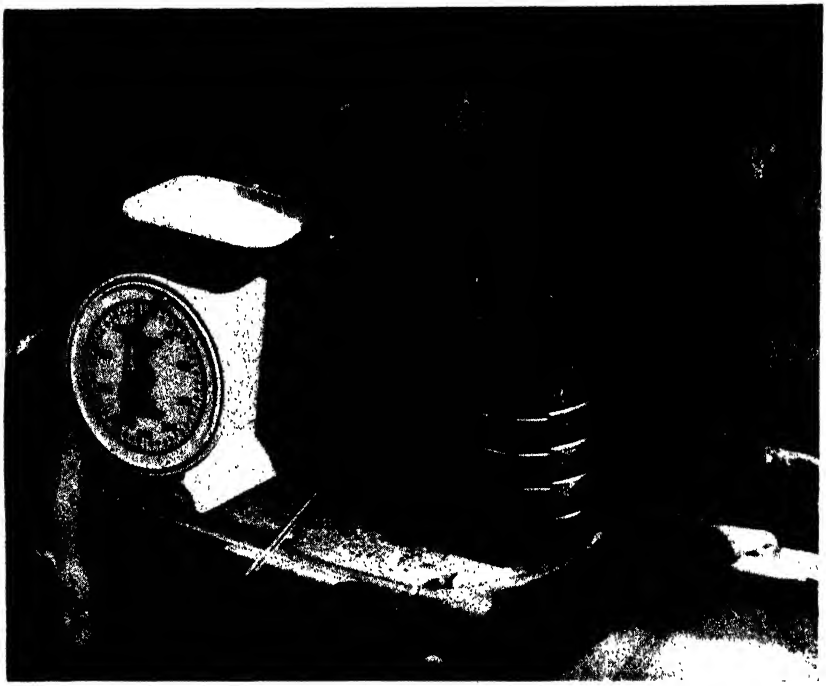

Fig. 2. The oven, the cylinder, the scales, the thermometer and the gloves used in the determination of water in hay.

PROCEDURE

In obtaining the figures in Tables 2 and 3, the following procedure was used.

1. Selecting the sample is by far the most difficult and exacting part of the entire process. If a representative sample can be obtained the rest is easy. In selecting a representative sample, it is a good idea to avoid extremes of dryness and wetness. Try, rather, to select a reasonably uniform sample that represents most of the hay that will be hauled in the first hour or two.

2. Place the empty cylinder on the scales, and move the face so that the pointer rests at zero (Fig. 3A).

3. Fold the sample of hay two or three times, lengthwise, to approximately the length of the metal cylinder. It is best to cut the folds with a knife and to trim off hanging ends. Place the sample in the cut

Fig. 3A (upper left). The cylinder is placed on the scales and the face turned to read "0".
Fig. 3B (upper right). The sample is placed in the cylinder and weighed (164).
Fig. 3C (center). The cylinder and sample are placed in the oven.
Fig. 3D (lower left). The temperature is tested after a minute or two of rapid operation of the engine. 140° C. is a desirable temperature for rapid work.
Fig. 3E (lower right). The sample, after two or three weighings, has reached constant weight (112).

cylinder. Avoid undue crowding. There must be good circulation of air.

4. Re-weigh the cylinder with the enclosed sample, reading now the net weight of the hay (164 grams) (Fig. 3B).

5. Squeeze the cylinder to a size sufficiently small that it can be inserted in the oven (Fig. 3C).

6. Pull the cylinder out somewhat, so that the entire sample is enclosed in the oven and the extended cylinder. In the photographs this is not done, to allow the hay to show in the picture.

7. The engine has, presumably, been idling so that the exhaust pipes are hot. Now race the motor for a few seconds, depending upon the dampness of the hay. With ordinary hay, 15 seconds is sufficient, but the period may be longer with wetter samples. Let the engine idle briskly until about a total of 60 seconds is gone. Wearing gloves, pull out the cylinder with the sample of hay, and place again in the oven, reversing end. Again race the motor for a few seconds.

8. Note the temperature of the center of the sample (Fig. 3D). For rapid work, and yet accurate, a temperature of about 140° C. is desirable. At a lower temperature, the test requires more time. Adjust the throttle if necessary.

9. At the end of 2 minutes of heating, weigh the cylinder and sample, and return with ends reversed to the oven. Reverse at the end of 3 minutes. Re-weigh at 4 minutes. Reverse ends at 5 minutes and re-weigh at 6 minutes, etc. If the temperature has been kept near 140° C., with hay approximately dry enough to go into the barn, the weights at the end of 4 and 6 minutes should be virtually identical. Figure 3E shows the final weight 112 grams.

METHOD OF COMPUTING

This sample went from a weight of about 164 grams to a dry weight of about 112 grams. This loss of 52 grams (164 minus 112) represents the water in the sample. Divide 52 by 164 and the answer is 31.1-percent moisture in the sample. This sample was not quite dry enough to go into ordinary storage. Table 1 shows how to construct a chart to use in avoiding all further computations.

A student who had never seen the device was given the foregoing instructions and was requested to determine the percentage

TABLE 1—*Chart of moisture calculations*

Weight of sample	Percentage of moisture if the sample dries down to the figure given														
Gm.	Percent..	40	38	36	34	32	30	28	26	24	22	20	18	16	14
150	Dries to	90	93	95	99	102	105	108	111	114	117	120	123	126	129
148	Dries to	89	92	95	98	101	104	107	110	113	116	119	122	125	128
146	Dries to	88	91	93	96	99	102	105	108	111	114	117	120	123	126
144	Dries to	86	89	92	95	98	101	104	107	109	112	115	118	121	124
142 140 138 136	As example:	If a sample weighing 144 grams (col. 1) dries to a weight of 98 grams (follow the 144-gram line down until the number 98 is found) the percentage moisture is 32, i.e., the number at the head of that column.													
134 132 130 128	Another example:	If a sample weighing 128 grams dries down to a weight of 91 grams (between 90 and 92) the percentage moisture in the sample is 29%, since it comes halfway between the figures 28% and 30%.													
...	Dries to	77	79	82	85	87	90	92	95	97	100	102	105	108	110

moisture in several samples. To test the general accuracy of his work, on the first day he kept other samples in paper bags, which could later be tested for moisture in the laboratory. These samples dried out somewhat during the intervening hours, but otherwise show good agreement (Table 2).

Another collection of samples was made by the same student for further tests. In this case, he selected three or four additional samples from each lot of hay which were placed in moisture-proof "pliofilm" bags, until the laboratory determination of moisture at 103 C. could be made in the electric oven an hour or two later. Table 3 shows the

TABLE 2—*Preliminary determination of percentage moisture in hay showing the weights of samples after various intervals of heating*

Species	Minutes in heating in the exhaust oven (Weight in grams)								Percent moisture found	
	0	2	4	6	8	10	12	14	Exhaust oven	Electric oven
1. Mixed grass	101	86	85	85	....	....	....	....	15.8	13.2
2. Mixed grass	153	138	115	99	94	89	83	80	47.7	44.3
3. Mixed grass	129	88	84	82	81	80	....	....	38.0	36.3
4. Mixed grass	97	79	76	75	75	....	....	....	22.7	20.7
5. Alfalfa	183	123	80	69	65	64	64	....	65.0	65.1
6. Oat grain	172	147	135	130	126	125	....	....	27.3	27.1

On sample 2, the operator permitted the oven temperature to remain around 110°.
On sample 3, the operator speeded the engine up, at first, but then lagged.

TABLE 3—*Determination of percentage moisture in samples of hay—Column A, in the exhaust oven; Column 1-4 in the electric oven*

Species	Minutes elapsed in heating in the exhaust oven							Percent moisture found					Average
	0	2	4	6	8	10	20	Exhaust oven	Electric oven				
	Weight in grams							A	1	2	3	4	
Timothy	125	110	103	100	99	98.5	....	21.2	23.2	25.0	26.4	27.0	24.6
Brome	137	112	107	105	104.5	....	....	23.8	18.9	19.1	22.1	21.5	21.1
Alfalfa	134	106	97	95	93	92.5	....	30.9	....	29.9	30.7	31.4	30.7
Alfalfa	108	78	73	68	68	....	....	37.0	36.7	...no samples...			36.8
Alfalfa	95.5	80	76	74	73	73	....	23.5	25.3	21.5	24.8	....	23.8
Reed canary	130	107	101	97	96.5	....	....	25.7	22.6	25.9	25.0	25.0	24.8
Red clover	85	70	68	67	66.5	....	....	21.7	22.6	25.0	17.7	19.5	21.3
Sweet clover	139	99	92	88	86.5	86	....	37.7	34.3	35.3	40.3	39.7	37.5
Sudan grass	180	150	127	112	105	100	75	58.3	57.0	56.2	50.8	54.9	55.4

comparative results of the moisture determinations using the electric oven and the exhaust-pipe oven.

Again, the table gives clear evidence of the fact that the operator sometimes did not hurry the samples along as rapidly as he might have done. Nevertheless, on the average, the exhaust pipe determination seems more dependable than that from the laboratory samples. The exhaust pipe samples averaged about 125 grams in weight; sample 1, laboratory, averaged 60 grams, and samples 2, 3, and 4 averaged about 35 grams each, and were intended to be identical triplicates in each case.

From this table, the extreme difficulty in obtaining strictly identical samples is made clear. Many other similar tests have shown the same difficulty. Since, in each case, the sample dried in the exhaust pipe oven was approximately as large as three of the laboratory samples, the results from it are probably more dependable than from any small sample no matter how it is handled. The oven was designed to hold a little more than 100 grams of dry hay. There is no reason why it should not be larger, if one feels it desirable, since the capacity of the scale is adequate and the heating capacity of the discharge gases is abundant.

DISCUSSION

The exact procedure described here need not be strictly followed in actual practice. It is desirable, nevertheless, to follow it in a general way. The initial rapid heating by racing the motor is definitely helpful to heat the sample rapidly and to prevent condensation of steam in the colder parts of the hay. Reversing ends after about a

minute and once or twice thereafter takes only a few seconds and assures the operator that the sample is thoroughly heated. It takes but a few seconds to read successive weights if the scales are sitting in the trunk of the car or on the frame of the tractor. Incidentally, it is desirable, from the standpoint of ease and accuracy in reading the scale, that it be placed where there is some slight vibration from the motor. Tapping the scale-box with the finger tips accomplishes the same effect. So long as the sample is not burned—slight browning is not objectionable—the temperature control is not essential. About 140° C. (300° F.) is, nevertheless, a desirable heat for rapid and safe work. It is, of course, possible to char a sample, or very likely, even to set it on fire although this has never occurred in the course of our experimentation. This would require rather prolonged operation of the motor at high speeds and complete neglect of the sample during the analyses, both of which are inadvisable.

The scale costs a few dollars, but is generally useful, particularly if weights in both grams and ounces are printed on the face. A thermometer is useful for testing hay temperatures in the mow, etc. If one is putting hay in a mow drier, or is baling hay or making silage, the percentages of moisture required are widely different—perhaps 35 percent for the mow drier, 21 percent for the baler and 68 percent for the silo. If necessary, by the use of a wire-netting basket, the moisture content of grains may be determined. Table 4 gives the maximum moisture content commonly considered safe for storage of various products on the farm. Obviously, these maxima vary considerably according to the bulk of the material to be stored at one time or in one place, upon the ventilation of the storage space, and so forth (1).

TABLE 4—*Maximum moisture contents generally permissible at the time of storage under Michigan warm-weather conditions. Recommendations for the mow-drier are more flexible than those for ordinary storage.*

	Ordinary Mow or Bin Percent moisture	Mow-drier-installation Percent moisture
Hay, loose	23–27	33–37
Hay baled, loosely	23	28–32
Hay baled, tightly	20	25–27
Hay, chopped	19–21	28–33
Oats	15	
Barley	15	
Wheat	14	

To determine the percentage of moisture will take about 6 minutes. Yet, considering the value of the product, the time and effort that have been spent in growing it and the time and effort that will be spent in harvesting and feeding it, this additional labor is warranted. There is no reason why a junior member of the family might not be trained to make this test. Routine use of the test—an hour or two each year—should generally improve the quality of our hays and reduce fire hazards incident to haying.

SUMMARY

A cylindrical oven, about 4 inches in diameter and 10 inches long, was attached to the exhaust pipe of a gasoline engine (automobile). The discharge of hot air through a weighed sample of hay rapidly reduced the sample to constant weight. At the recommended temperature of about 140° C. approximately 6 minutes are required in making an accurate determination of moisture content.

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HARD SURFACING OF PLOW SHARES

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SECTION OF AGRICULTURAL ENGINEERING

SEVERAL years ago when hardening alloys were first applied to the cutting edges of plow shares, it was found that favorable results were obtained in many instances. These favorable cases were those in which the alloy was applied to the point and the cutting edge of steel shares. Chilled iron shares were weakened by the application of the hard surfacing material and broke easily when encountering stones in the field.

The results, as reported by about one hundred farmers, indicated that a steel share with the hard surfacing material expertly applied increased the working life of the share from two to four times, as compared with the untreated steel share.

Since these early tests were conducted on farms scattered throughout the state, no attempt was made to determine the points of greatest wear on the plow share.

During the past year additional information was secured bearing upon this matter of wear. A Ford-Ferguson two-bottom plow was equipped with one bottom in which the steel share was treated with a commercial hard surfacing alloy and the other bottom had a regular, untreated steel share. It required 23 hours of actual field work to cause wear on the shares sufficiently great to prevent further good plowing.

Both shares were accurately measured and weighed before and after the conclusion of the test. Figure 1 shows an outline of the worn alloy treated share superimposed on an outline of the new alloy treated share. Figure 2 shows the same relationship for the untreated share.

An analysis of Figs. 1 and 2 shows a rather marked advantage in favor of the alloy-treated share in minimizing wear and also how the wear was distributed at the point and cutting edge of the share.

Actual measurements show that 1⅜ inches of metal has been worn off the untreated share. In both cases the amount of wear is significant.

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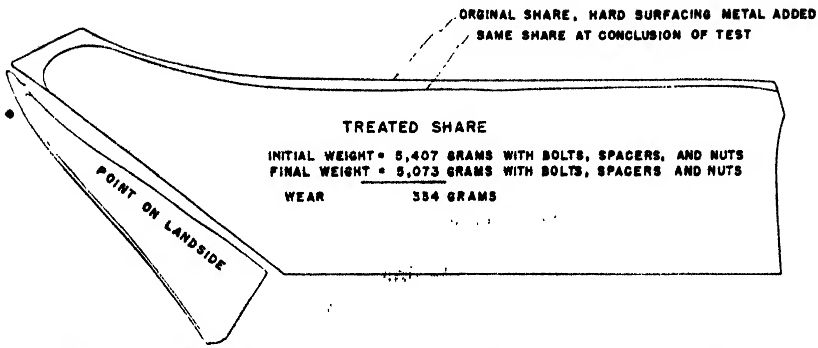

Fig. 1. An outline of the worn treated share superimposed upon the new treated share.

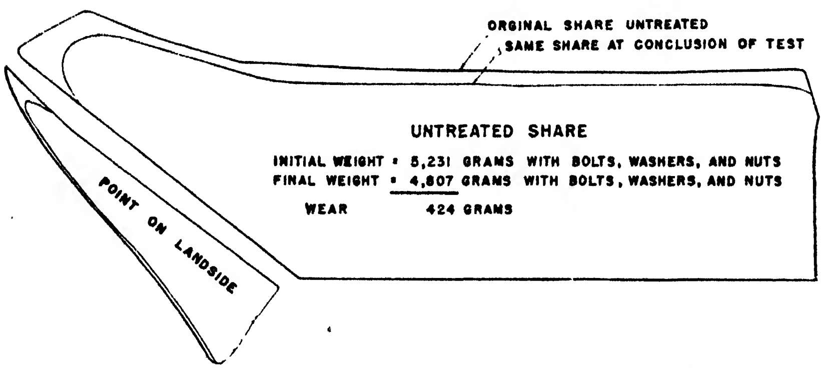

Fig. 2. An outline of the worn untreated share superimposed upon the new untreated share.

Obviously the hard surfacing alloy acted as a deterent to wear, but the extent of the wear indicates that the alloy material had been punctured and that wear was taking place in the steel structure of the share. This suggests the need of additional reinforcing of the share point with the hard surfacing alloy to protect the base metal.

Figure 3 shows the two shares after they were removed from the plow. The shaded portion represents the bottom of the share and the light portion, the landside. The alloy treated share at the left shows a distinct advantage over the untreated share at the right.

The total weight of material worn from the two shares was 334 grams for the alloy-treated share and 424 grams for the untreated share.

New techniques are being devised by those interested in the hard surfacing of the cutting edges of farm tools. The presence of stones in much of our Michigan soils makes it difficult to evaluate properly the effectiveness of hard surfacing alloys. The wide use of hard surfacing alloys, especially as applied to plows, is an indication of acceptance by Michigan farmers.

Fig. 3. The treated share to the left indicates some advantage in wear resistance as compared with the untreated share at the right.

EVALUATION OF GROWTH RESPONSES RESULTING FROM INTERNAL AND SURFACE APPLICATIONS OF 2,4-D TO BEAN PLANTS

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SECTION OF HORTICULTURE

IN STUDIES of growth effects resulting from 2,4-D action on bean plants, a quantitative method for the determination of the effectiveness of treatments has been generally accepted, by which the total fresh or dry weight produced above the second node, subsequent to treatment, is compared with that of control plants (3, 5, 6, 8, 9, 10). This method of evaluation, however, did not always prove satisfactory, especially when such growth was a composite of normal and abnormal, proliferating tissues, and originated from definitely different morphological units. An attempt was made, therefore, to develop a new procedure of evaluating the effect of 2,4-D treatments in similar experiments, with the objective of including also qualitative characteristics of growth responses.

Definite correlations existing between certain parts of bean seedlings subsequent to treatment were evident. The terminal growing point seems to direct the activities of all other parts of the plant. If this center is affected by 2,4-D, also more or less remote morphological structures will indicate by their modified function the degree of inhibitory or stimulating effectiveness of the chemical agent. The relationship between terminal and lateral growth and the formation of apical tumors seemed a most reliable criterion on which, therefore, determinations of fresh weight were based.

EXPERIMENTAL

Seeds of Red Kidney bean, selected according to equal size and weight, were singly planted in 4-inch pots filled with compost soil, and covered with a thin layer of sand or peat moss. After about 10 days, when the seedlings had expanded the primary leaves to half of their full length, and the terminal bud was just visible but still

ARTICLE 30-24

very small, equally sized plants were selected, and 8 to 10 of them grouped in rows designated for one kind of treatment. The plants were lined up uniformly, so that the longitudinal axes of all primary leaves were parallel.

The treatments consisted of applying aqueous solutions of the sodium salt of 2,4-dichlorophenoxyacetic acid: (1) in various concentrations, (2) adjusted to various pH values, or (3) mixed with other chemicals.

Applications were made by means of placing a drop on the base of one of the primary leaf blades, or by introducing the substance to be tested internally with a threaded needle (2). In the latter treatment the thread was pulled through the center of the second node of the stem, perpendicular to the position of the cotyledons. The drop treatments were always applied on those primary leaves which pointed in the same direction. The pipettes used for applying the drops were selected according to the uniformity of drops which they released. This was determined by weighing the drops. The amount of 2,4-D in drops of a 0.1-percent aqueous solution (1,000 ppm.) was between 0.054 and 0.059 mg. The amount of 2,4-D when directly introduced into the tissues with a fourfold cotton thread, was calculated by the differences of weight before and after soaking it to a saturation in a 0.1-percent aqueous solution. Several replicated weighings of each group of 10 threads, 5 cm. long, were made, and the results then rectified to the actual length of tissue in contact with the thread. Consequently, the absorbing capacity of a thread of 0.25 cm. length was determined to be 0.057 mg. Therefore, the amounts of 2,4-D introduced either by thread into the second node of the stem or by a drop on the surface of a primary leaf, were considered as practically identical, i.e., about 0.057 mg. (or 57 micrograms).

GROWTH RESPONSES

The various types of growth responses resulting from 2,4-D treatments of bean plants have been described by other investigators with regard to morphological and histological changes of normal development (1, 4, 7). They may be briefly summarized in the chronological and spatial sequence in which they usually occur with bean seedlings under experimental conditions as previously described, and when treated 10 days after planting:

(1) Curvature of the first internode, or epinastic response of one or both primary leaves after 4 to 16 hours. These curvatures are reversible, and may disappear after 48 hours, if the effect is rather weak.

(2) Delayed terminal growth, formation of a short, more or less swollen second internode. Compound leaves developing with mosaic-like symptoms within 10 days.

(3) Inhibition of terminal growth with consequently prematurely formation of lateral shoots in the axil of the primary leaves after 5 days.

(4) Light yellowish or whitish discoloration of the stem, coupled with a swelling of the first internode and hypocotyl, indicating the formation of root primordia. Development of an apical tumor after 6 to 8 days. If the apical tumor is to remain small, also axillary tumors develop, inhibiting lateral growth.

(5) Adventitious roots burst through the surface of hyperplastic regions of the stem, crushing cortical tissues within 10 to 14 days.

(6) Complete inhibition of aerial growth. Plant dies within 1 to 3 weeks.

Virtually, this sequence of growth responses corresponds to an increase of strength of the applied 2,4-D preparations. It is true, that frequently some irregularities and transitions in the enumerated order of reactions occur among experimental series, even under most accurate and controlled conditions. However, certain correlations between suppressed growth, malformation and compensative growth were consistent and indicative of the specific intensity of effect of the applied chemical.

Following are a few typical examples of such experiments, together with a discussion of the findings.

Experiment 1. Table 1 refers to an experiment in which the effect of a 2,4-D solution containing aluminum chloride was tested by the "thread method." The figures represent averages of 8 plants in each group. The entire growth above the second node of each plant was weighed without further distinction of its specific origin. Linear measurements of the first internode, expressed in ratios between length and width, were made as a supplementary determination.

The first internode is one of the morphological structures of the seedling which is already differentiated at the time when treatments

TABLE 1—*Evaluation of growth responses of bean seedlings by weights and linear measurements*

Experimental group	Treatment	Entire growth above 2nd node. Average fresh weight gm.	First internode		
			Length cm.	Diameter cm.	Ratio length/width
1	Untreated	5.83	4.20	.47	8.9
2	1% aq. $AlCl_3$, pH 2.6	4.84	3.28	.48	6.8
3	0.1% aq. 2, 4-D, pH 5.8	4.04	3.10	.57	5.4
4	0.1% 2, 4-D, in 1% aq. $AlCl_3$, pH 2.8	0.91	3.50	.66	5.3

are made. A downward transmission of 2,4-D from the place of its application (second node) to the first internode and hypocotyl may cause abnormal cell divisions in their subepidermal tissues. Subsequently, these parts appear more or less swollen, and their longitudinal growth may be restricted.

The greatest differences in weight and ratio are noticeable between control plants and the group which was treated with the mixture of 2,4-D and $AlCl_3$, indicating that $AlCl_3$ is able to increase the effectiveness of 2,4-D, although this chemical alone does not appreciably affect the plant. The figure of weight, however, gives only very general information on the comparative effectiveness of the various treatments, and is not correct in a strict sense. Actually, only the groups 1 and 2 produced terminal growth, while the plants of group 3 chiefly formed lateral shoots, and group 4 had large apical tumors with adventitious roots developed, which greatly reduced all other growth. These formative effects are hardly expressed by the total amounts of entire growth above the second node. Neither is the real growth performance of the first internode indicated by the ratio alone, since internodial length was only little affected, but the changes in width were decisive. The length of the internodes in group 4 is even greater than in group 3; therefore, these data without additional measurements of corresponding width would be completely misleading.

In the course of similar studies, an attempt was made to eliminate the shortcomings of such manner of presenting data. Finally a method of evaluation was adopted which enabled a combined determination of both quantitative and qualitative growth responses that were considered most significant in illustrating the effect of chemical treatment.

Experiment 2. In this trial the effectiveness of different concentrations of 2,4-D solutions (1,000, 500, and 250 ppm.) was tested. One group of plants was treated by external application of a drop of the

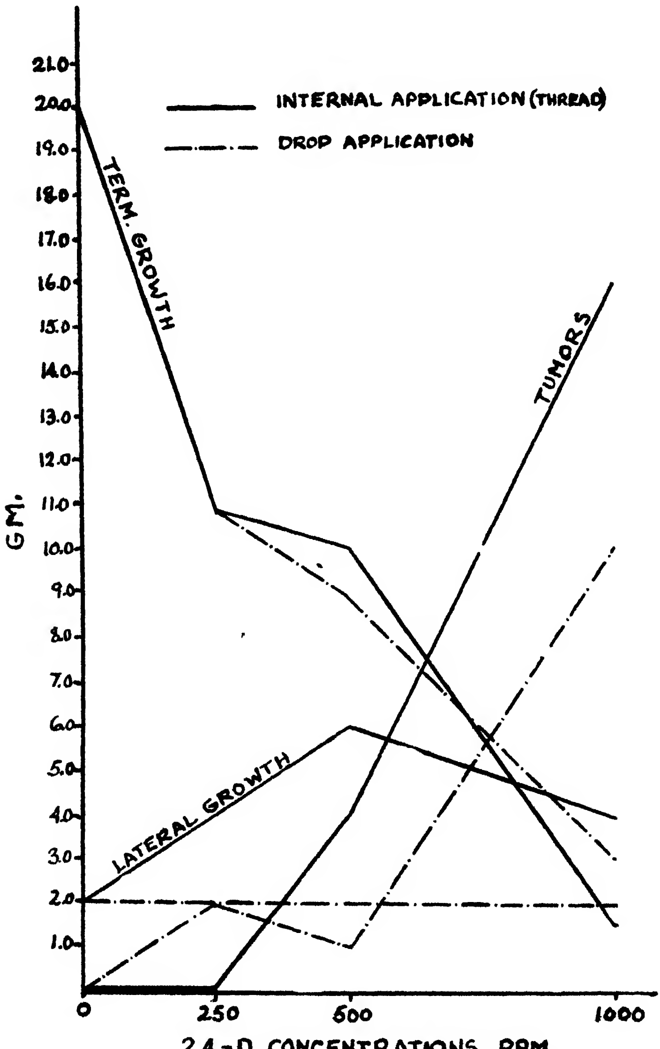

Fig. 1. Evaluation of growth responses of Experiment 2. Inverse relationship between terminal growth and tumor development, subsequent to treatments with 2,4-D solutions of different concentrations applied by "thread" or "drop."

respective solution, and the other group was treated by introducing the agent by the "thread method" (2). The growth resulting from both applications of different 2,4-D concentrations is graphically presented in Fig. 1. The amounts of fresh weight of terminal and lateral growth and apical tumors are plotted in such a way that the relatively light weight of lateral shoots and of tumors is expressed in decigrams in contrast to the weight of terminal growth which is given in grams. Two different scales of reproduction are thus used in the diagram, in order to emphasize the inverse correlations. The differences in weight of terminal growth in the drop and thread treated groups are rather small. There are practically none when the plants responded to the application of a solution containing 250 ppm. of 2,4-D, and they amount only to 1 gm. and 1.4 gm. in the cases when higher 2,4-D concentrations of 500 ppm. and 1,000 ppm., respectively, were used. Largest tumors developed in the group of thread treatment with the concentration of 1,000 ppm.; however, no tumors were formed at the 250 ppm. level subsequently to thread application, while in the corresponding group of drop treatment small hyperplasiae (0.2 gm.) were present. The average fresh weight of lateral growth in the group of drop treatment remained on the same level of 0.2 gm. throughout all concentrations without differing from that of control plants. The thread treatment with 2,4-D, 500 ppm., however, caused the growth of three times as many lateral shoots (0.6 gm.); this was accompanied by less terminal growth and the formation of more apical tumors than in the corresponding drop treatment.

By viewing the results of the tests as a whole and as illustrated by the graph, the following conclusions can be drawn: (1) An increase of inhibitory effects corresponds to increasingly higher concentrations of applied 2,4-D solutions; (2) the consistent inverse relationship between formation of terminal growth and tumors is in agreement with the varying amount of corresponding lateral growth, most of which results from the intermediate 2,4-D concentration, i.e., 500 ppm.; a slightly greater effect of 2,4-D is evident when it is introduced by thread than when applied by drop. Apparently, also the growth responses caused by thread treatment are more differentiated, and may offer, therefore, better insight into details of growth relations of plants.

Measurements of the length of the aerial parts of the hypocotyl, of the first internode and the blades of the primary leaves were made at the time of treatment and again at harvest, in addition to the weight

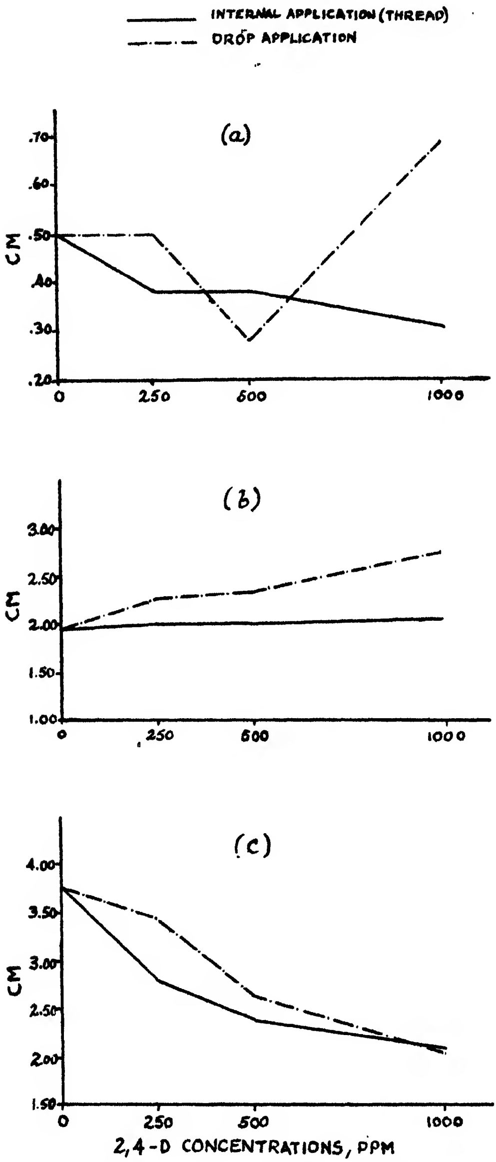

Fig. 2. Average length increases of hypocotyl (a), first internode (b) and primary leaf blades (c) after treatments with different concentrations of 2,4-D solutions, applied by thread or drop.

determinations. The increase in length was calculated with regard to the three structural units for each plant. The average increases of length of these organs are illustrated by graphs in Fig. 2. Also, the results of linear measurements indicate that the effectiveness of 2,4-D applications by thread is more prominent and more regular than by drop, supporting the results obtained by weighings. Although the developmental pattern of growth subsequent to internal or external treatments with 2,4-D solutions is altered in the same directions, according to the effect of various concentrations of substance used, the specific responses are more uniform when they result from internal treatment, and therefore may be more reliable for purposes of evaluation than surface applications.

Experiment 3. This test was designed to determine the effectiveness of acidified 2,4-D solutions. Different pH levels were adjusted

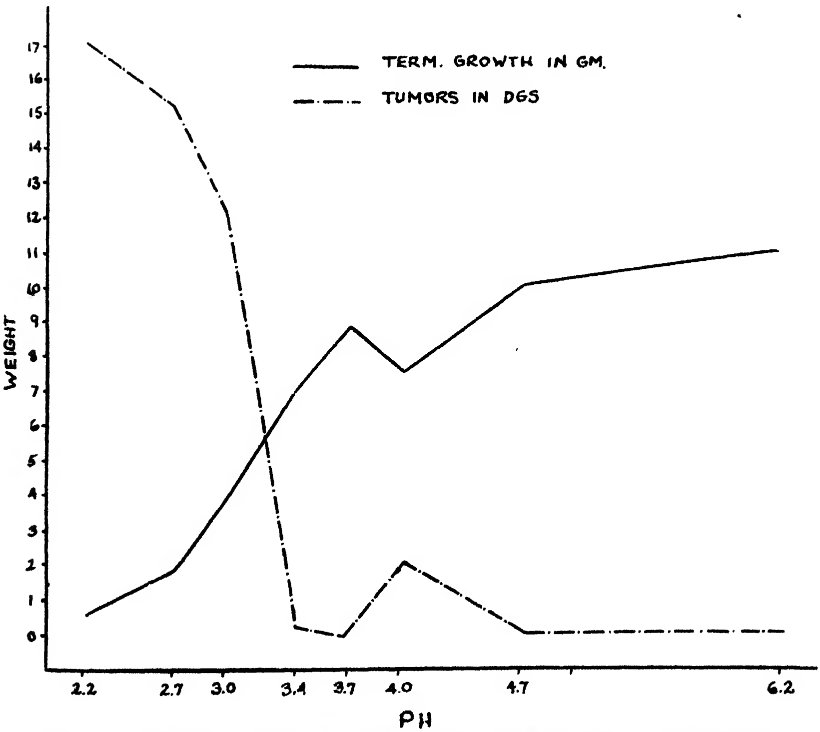

Fig. 3. Evaluation of growth responses of Experiment 3. Fresh weight of terminal growth and tumors used to determine the effectiveness of 2,4-D solutions at different pH levels.

by adding proper amounts of phosphoric acid to 2,4-D solutions of 500 ppm. Applications were made by the drop method. Eight plants were used for each treatment. The results are represented by a graph in Fig. 3. The data referring to tumor weight are plotted in decigrams, those of terminal growth in grams, for similar reasons as mentioned in the description of experiment 2. Lateral growth in this experiment showed no significant differences, and is not presented.

The result indicates that at pH levels above 4.7, normal growth becomes increasingly vigorous, tumors being completely absent. However, with increasing acidity, at pH levels between 3.7 and 2.2, terminal growth is more and more restricted, while tumors increase remarkably. At a pH of 4 an interruption in the inverse correlation between decreasing acidity of 2,4-D solutions and inhibitory effect is evident. However, the inverse correlation between terminal growth and tumor development is maintained without exception.

The general result of this single experiment is in agreement with earlier reports (3, 5) that acidification of aqueous 2,4-D salt solutions greatly increases their activity.

CONCLUSIONS

The method described is more accurate than the procedure of evaluation which determines the weight of growth of different origin as a single unit; the higher accuracy is due to the morphogenetic specification of growth subsequent to the treatment. Although separate weighings are more time-consuming than is the single determination of the entire growth, they increase the reliability of data obtained for statistical treatment, particularly in experiments where small numbers of plants are used.

Linear measurements of certain organs may give supplementary information of growth responses in some cases, but are not always essential. Proper preliminary observation of morphogenetic correlations and selection of susceptible plant regions which, at specific stages of development, respond most readily to physiologically active substances, will indicate the organs whose growth responses can be determined most satisfactorily.

The procedure of evaluation which is demonstrated in its application to bean plants treated with 2,4-D solutions may be equally valid for experiments with other plants or with other chemicals. It will depend on the ability of the investigator to detect the most significant

characteristics of plant responses to introduced substances in order to find the true relationship between form and metabolic factors in plant life.

SUMMARY

1. The effectiveness of internal and external treatment with 2,4-D solutions was compared. The direct introduction of the test substance into plant tissue by thread and needle gave better results with regard to uniformity and specificity of growth responses than surface application by means of a drop.

2. A method of evaluation is presented which uses the amount of fresh weight produced by terminal growth, lateral growth and tumors, subsequent to treatments with 2,4-D solutions, as an index of correlative growth responses in bean plants. It makes it possible to express simultaneously quantitative and qualitative changes of growth, thereby relating specific substances to form phenomena.

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LENGTH OF GESTATION PERIOD IN BROWN SWISS

By EARL WEAVER, E. D. WETTSTEIN, and RUSSELL E. HORWOOD*

SECTION OF DAIRY

FOR SEVERAL years in the operation of the Michigan State College dairy herd it has been surmised that Brown Swiss females exhibit a specific breed characteristic in that they carry their calves *in utero* for perceptibly longer periods than the other breeds. Conventional gestation tables to indicate the probable date of freshening when a cow is bred on a specified date have been formulated and used for many years. These tables are based on the assumption the gestation period is 281 or 283 days. Some dairymen roughly calculate that a cow will freshen in nine months plus a week after she conceives.

In the College herd the breeds other than Swiss usually show approximately the expected duration of pregnancy when normal freshenings are involved. However, the Swiss almost invariably are delayed. It was felt that a careful study of the length of lactation in this breed was desirable.

REVIEW OF LITERATURE

The studies made several years ago and which did not include records on Swiss are the chief basis for the acceptance of the figures of 281 to 283 days as the average length of the normal gestation in cattle. Rice (6) indicates it is 281 days. Lush (5) gives the figure of 282.1 days as the average of 27,810 cases studied. It has always been acknowledged that individual cases vary widely.

In the earlier data the possibility of breed differences was largely ignored. Even today most cattlemen presume the gestation period to be the same for all breeds of cattle. Lush recognized there are breed differences but that they are usually slight.

Henderson (2) nearly 10 years ago, with data from six dairy breeds, reported the over-all average for all six breeds was 281.7 days but the separate average for Swiss alone was 287.4 days. Barrett (1)

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ARTICLE 30-25

states from his observations with the dairy herd at the University of Wisconsin that the Swiss "have had an average gestation of 289 days, which is about a week longer than is generally given for the Guernsey breed."

Rife and co-workers (7) in 1943 reported that purebred Angus calves were carried 272.8 days, while purebred Herefords were carried 289 days with crossbred calves intermediate.

Livesay and Bee (4), from more extensive data with West Virginia University herds, found the average for Angus was 282.5 days and for Herefords 285.2 and that the difference was highly significant statistically. These same workers further established that the two beef breeds have significantly longer gestation periods than the three dairy breeds on which they obtained data, namely: Jersey, Ayrshire and Holsteins. The average for Jerseys was 277.9 days, for Ayrshires 277.8 days, and for Holsteins 278.3. These workers emphasize that a shorter gestation period is not explained on a basis of earlier maturity for the breed. Thus Jerseys, which are acknowledged for earlier maturity, did not show the shortest gestation.

Herman and Spalding (3) studied 1937 gestations involving Holsteins, Jerseys and Guernseys and found the combined average for the three breeds was 279.4 days. Holsteins showed the shortest gestation, with an average of 278.1 days, then Jerseys with 280.4 days and Guernseys longest with 284.0 days.

It is noted that few data have ever been obtained on the length of gestation in Swiss.

SOURCE OF DATA

For the study reported here use was made of breeding and freshening records of Brown Swiss females in the College herd for the 22 years July 1, 1924 to June 30, 1946. In any herd some records that are entered in a routine way are subject to inaccuracies. Furthermore, in handling Swiss females it is observed that more-than-usual difficulty is encountered in determining if the animal is definitely in heat. In such situations and where artificial insemination is used the tendency is to re-breed a female when she is suspected of being in heat though the judgment is not positive and she may have already conceived at the previous breeding date. Then at freshening it is not always possible to determine which was the actual date of conception. For this study any gestation was eliminated if any date was questionable.

Furthermore, for this phase of the study, any gestation was eliminated if it resulted in twins or an abortion. A few gestations were also eliminated when they resulted in dead calves even if the calf were carried to what might be considered full-term.

With the limitations imposed, there were only 148 gestations remaining to include in the data. They involved a total of 50 dams. Data on more animals would be desirable.

As a matter of interest it is indicated that during the 22-year period there were 4 pairs of twins, 11 abortions and 3 calves dead at birth for which the data were excluded.

RESULTS

The average length of the 148 gestations was 291 days, which is a longer period than has ever been reported previously for a breed of cattle. Calculations of the standard deviation of a single determination gave a figure of 6 days. Thus under conditions such as pre-

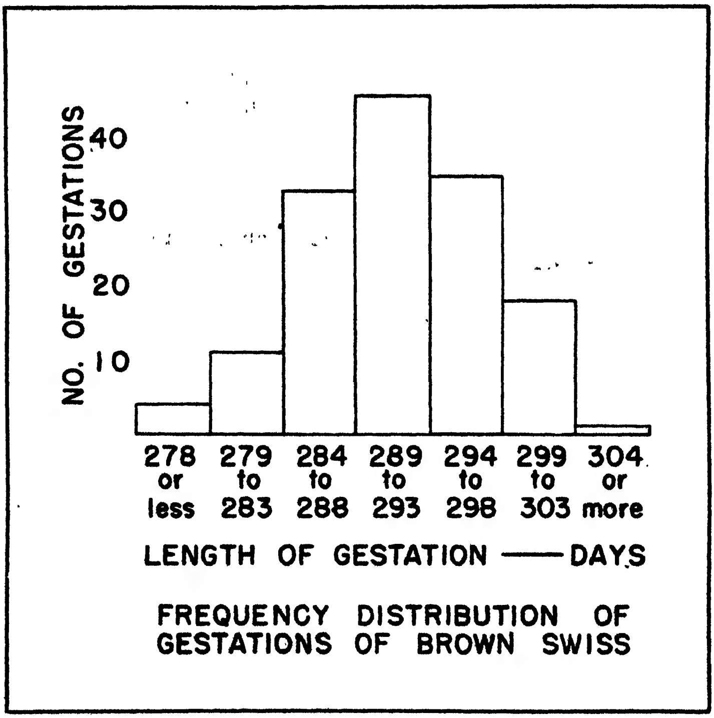

Fig. 1.

vailed in the College herd it can be presumed that approximately 68 percent of the gestations in Swiss may be expected to fall within the range of 285 to 297; i.e., 6 days shorter or 6 days longer than the average of 291 days. In our study more than two-thirds of the cases fell within this range. It was 74 percent. Then 12 percent of the gestations were shorter than 285 days and 14 percent were longer than 297 days.

The accompanying chart of the frequency distribution shows the numbers of gestations that came within the classes indicated (Fig. 1). Forty-six of them were 289 to 293 days in length. Only four were 278 days or less. The shortest gestation was 270 days. Only one gestation involved as long a period as 304 days; it was for 306 days.

MALES AND FEMALES

There were 73 male and 75 female calves. The males were carried an average of 291.1 days and the females 290.8 days. This difference is not significant. It may be noted that the longest gestation (306 days) was with a female calf and the shortest (270 days) was with a male.

It is quite commonly accepted that males are carried *in utero* for longer periods than females. But Lush (5) indicates that evidence on this point is contradictory and in reference to the influence of sex of the offspring upon the length of gestation he states, "This is probably never a major cause of variation."

Livesay and Bee (4), with their data from Jerseys, Ayrshires and Holsteins, report separate averages for male and female calves. In each case the males were carried slightly longer or 0.6 day for Ayrshires, 1.0 day for Holsteins and 1.4 days for Jerseys. But these authors imply their belief that the differences are of little, if any, significance.

Similarly, Herman and Spalding (3) found Jersey males were carried 1.0 day longer, Guernsey males also 1.0 day longer and Holstein males 1.3 days longer.

FIRST-CALF HEIFERS

Among the 148 gestations in this study, 46 were of first-calf heifers. These heifers carried their calves an average of 291 days, which is the same as the average for all 148 lactations. Here again the results do not substantiate a quite frequent belief that the first gestation of a female is likely to be shorter than subsequent gestations.

TWINS

During the 22-year period covered by these records only four sets of twins were born. This is 2.4 percent of all freshenings. The average of the four twin-gestations was 279 days. The shortest was 271 days and resulted in live heifers. Another gestation was 278 days and resulted in dead calves, a male and a female. The other two gestations were 284 days. In one case both twins were males and in the other both were females but one was dead at birth.

ABORTIONS

Eleven known abortions occurred during the 22-year period constituting 6.6 percent of all freshenings. The herd is regularly subjected to the agglutination test and during the entire period covered by the data no positive reaction has ever been obtained. Such abortions as occurred were due to some cause or causes other than brucellosis.

No objective can be accomplished by reporting the average length of time the calves were carried before they were aborted. The shortest time was 63 days, the longest was 263 days.

SUMMARY

With records of breeding and freshening dates of Brown Swiss females in the College herd affording 148 normal gestations on 50 cows the average length of gestation was 291 days. The standard deviation of a single observation was 6 days, thus signifying that approximately 68 percent of the gestations in Swiss can be expected to fall within the range of 285 to 297 days.

There was no significant difference in the length of the gestation for male and female calves. Similarly 46 first-calf heifers involved carried their calves an average of 291 days, which indicates that, at least with Swiss, first gestations of a heifer are no shorter than subsequent gestations.

The four sets of twins were carried for an average of only 279 days.

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SUGAR-BEET HARVESTER TRIALS IN MICHIGAN IN 1946

By C. M. HANSEN, R. W. BELL *and* G. W. FRENCH[1]

SECTIONS OF AGRICULTURAL ENGINEERING AND FARM CROPS, AND THE UNITED STATES DEPARTMENT OF AGRICULTURE

SUGAR-BEET growers in the Michigan area experienced in 1946 an unusually dry September-October harvest period, total rainfall for these two months being the lowest for the past 60 years. Precipitation throughout the Michigan beet-growing areas for the period of July, August and September was the lowest ever recorded by the U. S. Weather Bureau. Soil conditions during the early part of the harvest period were, nevertheless, very nearly ideal for lifter-topper-type sugar-beet harvesters. Ground-topper-type harvesters had to contend with a clod problem which in some instances was solved only by the use of a hand-sorting table.

An appreciable amount of rain fell in the last week of October and intermittently during the remainder of the harvest season. During this period harvesters were operated under soil and weather conditions which more nearly approached those of the 1945 season. However, only those harvesters which were operated on heavy clay soils were kept from the field and, then, only for short periods of time.

Beets grown on mineral soils in 1946 for the most part developed long taproots. This made it necessary to adjust harvester lifter points to greater than usual depths, which in turn increased the draw bar requirements. Dry soil conditions caused a greater-than-normal amount of machine wear, particularly of the lifter parts, which had to be replaced at relatively short intervals.

HARVESTER STUDIES

Since 1943, Michigan State College and the U. S. Department of Agriculture have cooperated in sugar-beet harvester studies. The results from 1943 through 1945 have been recorded in the *Michigan*

[1]Acknowledgment is made of the substantial help given by the Farmers and Manufacturers Beet Sugar Association, Saginaw, and the various sugar companies of Michigan.

ARTICLE 30-26

Agricultural Experiment Station Quarterly Bulletin of August 1945, and May 1946. The objective of the 1946 mechanical harvester study was twofold: (1) that of making performance checks on a number of harvesters, farmer-owned and otherwise, chosen at random and; (2) developing a device, applicable to any type sugar-beet combine, by means of which dirt can be removed from the beet roots prior to their being loaded into an accompanying vehicle, or before being windrowed.

PERFORMANCE CHECKS

A total of 22 field tests were conducted on three different type harvesters. The first type is one which first loosens the beets in the soil by means of a single point lifter blade, after which the beets are carried by means of the leaves to a set of topping disks. In this paper such machines will be referred to as the lifter-topper type. The second type is a tractor-mounted, ground-topper which elevates the topped beets into an attached trailer. The trailer has an endless-belt sorting table, which may or may not be used. This is the only type of ground-topper machine tested. The third type tested is commonly known as the spiked-wheel harvester. Untopped beets are first loosened in the soil and then are carried to topping chisels by means of spikes located on the periphery of a large wheel.

Methods Used to Check Harvesting

The technique employed in making performance checks was as follows: A 100-foot section of row was marked out in what appeared to be a typical portion of the field and the number of beets in the section was recorded. Several soil moisture samples were taken at a depth of from 6 to 8 inches in the marked section of the row. The beets in the row were then harvested by the machine being tested. After the harvester had passed over the 100-foot section of row, the "tops" were gathered, and marketable tissue below the lowest leaf scar was cut from them and weighed. The beets which the machine failed to harvest were also counted and weighed. Tare and screening figures were obtained from the tare men at the factory weighing station. Results of 1946 performance checks are presented in Table 1.

TABLE 1—*Results of sugar-beet harvester performance checks on farmer-owned machines*

Field No.	Predominant soil series	Percent soil moisture	Percentage tare			Pounds of dirt per ton of clean beets (dirt tare plus screenings)	Marketable tissue unharvested per acre				Number of beets per 100 feet of row
			Crown	Dirt	Total		On unharvested beets		On "tops"	Total	
							Number of beets	Tons	Tons	Tons	
1	Carlisle Muck	97	4	2	6	256	373	.466	.488	.954	57
2	Miami-Conover	9	1	2	3	191	0	.000	.238	.238	85
3	Miami-Conover	15	3	2	5	154	186	.065	.218	.283	83
4	Brady Loam	13	4	3	7	270	560	.642	.242	.884	54
5	Brady Loam	13	3	3	6	191	62	.062	.704	.766	94
6	Brady Loam	19	3	3	6	239	560	.466	.074	.540	90
7	Conover-Brady	14	5	3	8	157	46	.023	.256	.279	56
8	Conover Loam	7	3	1	4	85	560	.280	.456	.736	76
9	Conover Loam	10	1.5	0.5	2	110	186	.093	.418	.511	87
10	Conover Loam	14	5	2	7	173	560	.280	.725	1.005	91
11	Conover Loam	16	5	1	6	213	186	.149	.261	.410	95
12	Conover Loam	17	2.5	0.5	3	166	373	.186	.101	.287	68
13	Selkirk Loam	9	9	2	11	337	186	.096	.336	.432	94
14	Brookston Loam	6	9	3	12	160	745	.372	.056	.428	83
15	*Brookston Loam	9	6	1	7	84	1116	.558	.139	.697	81
16	Brookston Loam	14	3	3	6	276	93	.093	.018	.111	93
17	Brookston Loam	18	6	2	8	207	186	.093	.680	.773	60
18	Brookston Loam	16	2	1	3	155	360	.280	.158	.438	86
19	Brookston Loam	21	5	1	6	253	373	.587	.233	.820	66
20	**Brookston Clay	7	2	1	3	56	186	.102	.018	.120	78
21	**Brookston Clay	26	2	26	28	1605	373	.130	.224	.354	72
22	**Brookston Clay	26	2	16	18	1169	746	.261	.242	.503	68
Average			3.8	3.5	7.3	296	364	.240	.286	.526	78

*Spiked-wheel harvester.
**Ground-topper harvester.
Remainder of field tests were on lifter-topper type harvester.
Sorting table used in field test 20, but not in tests 21 and 22.
In field tests 6, 10, 12 and 17 beets were windrowed by the harvester and picked up by mechanical loaders.

Hand Harvesting of Sugar Beets

Similar data was obtained on hand harvesting methods and, with one exception, data with respect to the number of beets left in any given field. No method was devised to accurately ascertain the number of beets left in the ground, or otherwise overlooked by the laborers. All reliable findings are included in Table 2.

Discussion—The comparison of the percentage tare data in tables 1 and 2 shows that the average for the season's operation of the mechanical harvesters is slightly higher than when hand methods were employed. However, an examination of all the percentage tare data indicates that when the operators completely familiarized themselves with the machine, and soil and weather conditions were favorable, more uniform results were secured.

The average pounds of dirt per ton of clean beets, dirt tare plus screenings, is only 36 pounds less for hand harvesting for the 1946 season. This is quite significant inasmuch as most of the beets went directly from the harvester to the vehicle which conveyed them to the weighing station. This method of handling did not permit the beets to lose dirt by drying. It should also, be pointed out that this method does not allow enough time to elapse as to reduce weight of the beets by shrinkage which is an important factor.

The average marketable tissue left on the tops by the machine is nearly twice that of the hand-harvested beets. This is not significantly important because of the saving due to reduced shrinkage by the more rapid method of handling.

SOIL MOISTURE CONTENT AND DIRT TARE PLUS SCREENINGS

There is reason to expect that the soil moisture content at harvest time should influence the amount of dirt tare and screenings in any given field. The data in Table 3 were obtained from the field tests of 18 farmer-owned lifter-topper type harvesters in which the beets were hauled directly to the weighing station. Similar data were also obtained from 11 hand-harvested fields.

The relationship between the soil moisture content and dirt in the load could not be shown graphically owing to the variables which must be considered. The tests were made on a wide range of soil series and classes which can, in themselves, vary in this relationship. The

TABLE 2—*Results of checks of hand-harvested beets*

Field No.	Predominant soil series	Percent soil moisture	Percentage tare			Pounds of dirt per ton of clean beets (dirt tare plus screenings)	Marketable tissue unharvested per acre	Number of beets per 100 feet of row
			Crown	Dirt	Total		On "tops"	
							Tons	
23	Miami Loam	19	1.0	1.0	2.0	104	.185	82
24	Miami-Brady	15	3.0	1.0	4.0	170	.102	85
25	Brady	10	6.0	1.0	7.0	188	.047	107
26	*Conover-Brady	12	1.0	2.0	3.0	193	.0	82
27	Conover-Brady	17	5.5	2.5	8.0	381	.018	69
28	Conover-Brady	20	3.0	0 0	3.0	173	.000	89
29	Brookston Loam	20	4.5	2.5	7.0	435	.515	90
30	Brookston Loam	24	3.0	4.0	7.0	432	.047	102
Average			3.37	1.75	5.12	260	.115	89

*Picked up by a mechanical loader. Remainder loaded by hand.

TABLE 3—*Comparison of performance checks with and without revolving steel brushes on Michigan State College Harvester*

(Soil Series—Conover Loam)

Moisture content of soil—percent	Pounds of dirt per ton of clean beets		
	Without brushes	With brushes	Average difference
16	186	144	42
17	104	66	38
18	519	270	249
18	425	183	242
19	494	243	251
22	433	349	84
24	419	192	227
Average	370	207	162

field moisture content of soils within a series will fluctuate markedly with the amount of organic matter and the extent of tiling.

Another variable occurs with the wide range of beet sizes. The larger beets, pound for pound, do not carry as much dirt into the load as do the smaller ones.

Add to this the possible lack of uniform techniques in securing the soil moisture and it is not difficult to understand the reasons for the erratic variations which occur in the tables. However, the data do show a definite trend in that if the soil moisture content is increased, the dirt in the load will also be increased.

MICHIGAN STATE COLLEGE DIRT REMOVAL DEVICE

Wet soil conditions prevalent during the 1945 sugar-beet harvesting season prompted further study toward development of a device for removing dirt from beets before being loaded into any accompanying vehicle or before being windrowed. Three factors were given special consideration in development of the device: (1) effectiveness, (2) applicability to the several types of harvesters; and (3) simplicity of design, the latter factor being associated with weight and cost of manufacture.

Description

The device which was developed embodied, in its final form, the use of brushes. The brush assembly was constructed by mounting 14-inch circular steel wire brushes on two parallel horizontal shafts. The wire brushes and shafts were then mounted within a rigid frame. The frame, in turn, was suspended by means of four springs directly

Fig. 1. Rotary brushes used to remove dirt from beets.

above the horizontal beet conveyor in such a manner that it was free to move vertically within a 10-inch range. Thus, the topped beets on the horizontal conveyor were brought into contact with the brushes. In operation, the brushes were rotated at a speed of 250 rpm., the direction of rotation being the same as that of the endless horizontal conveyor.

Performance Checks Made on Dirt Removal Device

Performance checks were made to determine the amounts of dirt delivered to the truck with and without the dirt removal device in operation. Fifty-foot sections of row were marked out and the number of beets in each of the sections was recorded. Soil moisture samples were obtained in a manner similar to that previously described. All the beets harvested in the marked section of row were caught in a canvas. The loose dirt and the dirt on the beets were then weighed. These checks were made in three different fields, all having soils of the Conover loam type. The tests were made in pairs, one with the brushes in operation and one with the brushes not in operation. Results of these performance checks are shown in Table 3.

Discussion

The soil moisture content during the performance checks ranged from 16 to 24 percent. In all the paired tests the amount of dirt delivered to the truck was less when brushes were used. An analysis of the results indicates that the average reduction in amount of dirt, 162 pounds per ton of clean beets, is statistically significant at the 1-percent point.

CONCLUSIONS

The following conclusions may be drawn from the presented data:

(1) Under conditions favorable to the operation of mechanical harvester, the quality of work done, as regards percentage dirt tare and percentage crown tare, was slightly lower than that of hand-harvesting, and

(2) The use of a dirt removal device, such as described, significantly lowered the amount of dirt delivered to an accompanying truck.

APPLICATION OF 2,4-DICHLOROPHENOXYACETIC ACID TO SOIL AS A PRE-EMERGENCE SPRAY TO PREVENT LODGING AND TO CONTROL WEEDS IN SWEET CORN

By C. L. HAMNER, H. B. TUKEY, *and* R. F. CARLSON
SECTION OF HORTICULTURE

THE POSSIBILITY of controlling weeds in cultivated crops by applications of 2,4-D to the soil to kill weed seed has been presented in previous publications (1, 3, 7). It has been reported that seeds not only of broad-leaved weeds can be killed by the treatment but also of many grasses. In addition, it has been established that the toxic effect of 2,4-D remains in the soil for about 2 weeks, after which it is rapidly dissipated, until after 4 weeks it has almost completely disappeared. The rate of dissipation of 2,4-D from the soil depends to a great extent upon soil moisture and temperature. Under dry conditions and low temperature, 2,4-D may persist in the soil for a considerable period (3).

Experiments have also shown (3) that certain crops are more resistant to 2,4-D in the soil than others. Wheat, for example, has been grown in soil containing certain 2,4-D concentrations in which weed seeds were destroyed but in which wheat germinated and grew normally. Also, gladioli (5) have been successfully weeded, with 2,4-D used as a pre-emergence spray applied to the surface of the soil. Using various amounts of 2,4-D per acre, it was determined that if the sodium salt of 2,4-D is applied to warm, moist soil at 5 pounds per acre, over 95 percent of the weed seeds could be destroyed in the upper 2 to 3 inches. Gladiolus corms planted 3 to 4 inches in depth were not adversely affected by a pre-emergence spray of 2,4-D. Thus, it was found possible to first plant gladioli corms, then spray the soil with 2,4-D and so control the weeds without cultivation. Applications of 2,4-D were most effective when applied to light, sandy soil and seemed to be least effective when applied to muck soil. It was thought that the organic matter present in the soil might be a factor in adsorbing the 2,4-D.

ARTICLE 30-27

Recent reports (2) have indicated that 2,4-D might also be used as a pre-emergence spray on corn. To test this possibility on sweet corn in Michigan, experiments were conducted at East Lansing on a Hillsdale sandy loam, using the Seneca Golden variety. Corn was planted on June 25 and on July 25 in rows 3 feet apart, drilled about 2 inches into the soil. Immediately after planting, a 70-percent preparation of the sodium salt of 2,4-D was applied to the soil surface. It was dissolved in just enough water to bring the chemical into solu-

Fig. 1. Typical development of brace roots on plants grown in soil to which 5 pounds per acre of 2,4-D was applied as a pre-emergence surface spray.

tion and applied as a concentrated spray with a knapsack sprayer to the soil plots at the rate of 5, 10 and 20 pounds per acre. The sprayer was equipped with a special nozzle which produced a fan-type spray. A more rapid and even distribution of the chemical was obtained with this fan-type nozzle than with one delivering a spray in the form of a cone.

There was considerable moisture in the soil at the time of planting. The early summer was cool and wet, whereas midsummer was warm and dry. Growth and development of the plants was satisfactory. Under these conditions very effective weed control was obtained with

Fig. 2. Development of roots on sweet corn following spraying of soil surface with 2,4-D.

(Left) 20 pounds per acre, showing anomalous formation of brace roots and heavy development of fibrous roots.

(Right) 5 pounds per acre, showing strong development of brace roots at second node above soil surface, and development of fibrous roots from these brace roots.

2,4-D at all three concentrations (5, 10 and 20 pounds per acre) at both planting dates. Some retardation in growth of corn resulted when 2,4-D was applied at the rates of 10 and 20 pounds per acre, but at 5 pounds per acre, no noticeably adverse effect was noted on either growth, yield or quality of corn. A mid-September frost prevented any accurate record of yield, but the possibility remains that an increase may have resulted from the 5-pound treatment.

One of the most striking effects from treatment was the increased development of brace or "prop" roots on all plots receiving 2,4-D. As shown in Fig. 1, brace roots commonly originated at the second node above the surface of treated soil, and were not infrequently found at the third node. This was in contrast to plants on untreated soil, in which brace roots appeared commonly only at the first node above the soil surface. These roots occasionally were broadly flattened, appearing as thick ribbons (Fig. 2). Also they were frequently green in color. On some plants they were so numerous and broad as to appear as a collar around the base of the plant.

Not only was there thus an increase in the number of tiers of brace roots on treated plots, but also there was a striking development of these roots when they came into contact with the soil. Frequently they developed a strong feeding-root system which completely filled the soil immediately adjacent to the plant with a sod-like mat (Fig 2).

To evaluate the relative abundance of roots at the different treatments, plants were dug by hand, the stalks removed just above the brace roots, and the remaining mass of roots washed and weighed. The figures, given in Table 1, show the comparative weights of roots.

All treatments with 2,4-D increased markedly this mass of roots immediately adjacent to the crown of the plants. In the case of 5 pounds of 2,4-D per acre, this root mass was largest and most extensive.

TABLE 1—*Relative weights of corn roots* from plots treated with 5, 10 and 20 pounds per acre of 2,4-D by a pre-emergence spray applied to the soil surface.*

Treatment	Average weight (ounces)
Control	2.1
5 pounds 2, 4-D per acre	9.0
10 pounds 2, 4-D per acre	6.5
20 pounds 2, 4-D per acre	6.2

*Corn plants pulled by hand, stalk removed just above brace roots, and remaining mass of roots washed and weighed.

Fig. 3. Lodging of corn plants (center) on untreated plots as contrasted with erect plants (right and background) on plots to which 2,4-D was applied as a pre-emergence surface spray.

At 10 pounds per acre, and even more so at 20 pounds per acre, the mass of roots was thicker and more heavily matted but the individual roots were shorter and extended less into the soil, so that the total weights were less.

This combination of increased number of tiers of brace roots and firm anchorage by penetration and branching into a mass of small roots immediately adjacent to the plants prevented blowing over during a severe storm which occurred September 21. Figure 3 shows plants from untreated plots which were blown over, alongside plants from treated plots which remained erect. This observation may be of importance in soil treatment of other crops with 2,4-D, such as wheat. It has been previously reported (3) that adventitious brace roots may develop on wheat plants grown on soil treated with 2,4-D.

The development of brace roots from soil treatments with 2,4-D

is in direct contrast to the inhibition of "brace" roots when 2,4-D is applied to corn as a foliar spray. With spray at a concentration of 1,000 ppm. the material may perhaps come into contact with root initials and so cause inhibition and distortion of the "brace" roots. On the other hand, when 2,4-D is applied to the soil at 5 pounds per acre as a pre-emergence spray, it is probable that the young and developing roots come into contact with a very much lower concentration. Since 2,4-D is readily dissipated in the soil under favorable conditions, the amount that persists may act as a root stimulant rather than as a depressant and so affect the larger root system and better brace root system on the treated plots.

The almost complete control of weeds at 5 pounds of 2,4-D per acre applied to warm, moist soil made it possible to grow the corn to maturity without cultivation. It is believed by some that cultivation of corn is unnecessary where weeds are otherwise controlled. Weidemann (9) in experiments to compare cultivation and no cultivation reports, "No striking differences could be observed during the growing season between the corn on the cultivated soil and that on shaved soil." In conclusion, he states, "until some selective spray material, or some other selective device, is developed that will kill all weeds without injuring the corn, we shall probably continue to cultivate, but there seems to be no particular advantage in cultivating any deeper or any oftener than is necessary to kill weeds."

The observations here reported, with 2,4-D as a soil treatment, suggests a chemical approach to the elimination of corn cultivation and in addition, the development of well-anchored corn plants which are better able to withstand blowing over by storms.

The success of this method for controlling weeds may depend upon many factors such as soil type, temperature, amount of rainfall, etc., and tests over a period of years should be made before general use can be recommended. However, the results that have been obtained warrant field trials under many conditions.

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SELF-FEEDING LAMBS WITH FOUR DIFFERENT MIXTURES OF GROUND ALFALFA AND CRACKED CORN

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PROPER FEEDING of lambs involves several important considerations such as rate of gain, economy of gain, control of death loss and finish or dressed yield. The ideal ration for each result desired may not be the ration for best all-around results. It is, therefore, necessary to use the ration that most nearly produces the best results possible when all objectives are considered.

Cox (1946) reported on seven tests each involving three lots of lambs, the first lot receiving 35 percent concentrates to 65 percent roughage, the second lot receiving 45 percent concentrates to 55 percent roughage and the third lot receiving 55 percent concentrates to 45 percent roughage. He concluded that an optimum proportion of concentrates to roughage exists and reported best results from the 45 percent concentrate and 55 percent roughage ration.

Blakeslee and Brown (1940) reported on two years' results of feeding two proportions of concentrates to roughage hand and self-fed.

The purpose of this report is to record the results of four different proportions of cracked corn and ground alfalfa self-fed to western feeder lambs in three tests for three successive years.

Corn and alfalfa are considered the basic ration commonly available for lambs. The proper use of these feeds will give good results, but too often sound information as well as experience is necessary before profitable results can be obtained. An experienced feeder may change the proportion of grain to roughage at the proper time, but a person without experience desires to know a mixture that will reduce death losses and produce good gains.

ARTICLE 30-28

OBJECTIVES

The objectives of this test were, therefore, twofold:

1. To find if possible a desirable proportion of concentrate to roughage which could be fed the entire feeding period with minimum danger of death loss from overeating.

2. To show the effects of the several mixtures on rate of gain, economy of gain, dressing percentage and death losses.

Table 1 shows the average results from three tests conducted in three successive years. The lambs were put on test in October of each year. The experimental period was 94, 98 and 112 days for each of the respective successive years. Each lot was self-fed the mixture indicated for the entire experimental period.

According to Table 1, the average daily gain tends to be greater when either 40 percent or 50 percent corn is fed in the lambs' ration.

If we summarize by years as in Table 2, Lot 5 receiving the highest proportion of hay and only 30 percent corn was consistently the slow-

TABLE 1—*An average of three years' results in self-feeding four mixtures of cracked corn and ground alfalfa, 1937-40*

	30% Cracked corn 70% Ground alfalfa	40% Cracked corn 60% Ground alfalfa	50% Cracked corn 50% Ground alfalfa	60% Cracked corn 40% Ground alfalfa
	Lot 5	Lot 6	Lot 7	Lot 8
Number of lambs finishing	60	58	56	57
Average length of feeding period (days)	101	101	101	101
Average initial weight (lb.)	56	56	56	56
Average final weight (lb.)	90	93	93	91
Average gain per lamb (lb.)	34	37	37	35
Average daily gain per lamb (lb.)	.34	.36	.36	.35
Death losses (percent)	0	5.	10.	7.5
Average dressed yield (percent)	45.84	48.08	49.18	49.68
Average daily ration (lb.)				
Ground alfalfa hay	2.08	1.72	1.34	.99
Cracked corn	.89	1.15	1.34	1.48
Feed fed per lamb (lb.)				
Alfalfa hay	6.5	6.46	6.42	6.37
Ground alfalfa hay	211.00	175.58	137.18	100.77
Cracked corn	90.42	117.00	137.18	151.14
Feed fed per cwt. gain (lb.)				
Alfalfa hay	18.67	17.45	17.22	18.01
Ground alfalfa hay	606.37	474.16	367.54	281.48
Cracked corn	259.87	315.97	367.54	422.23
Total feed fed per cwt. gain	884.91	807.58	752.30	721.72

TABLE 2—*Daily gain by trials, in pounds*

	Lot 5	Lot 6	Lot 7	Lot 8
	30% Corn	40% Corn	50% Corn	60% Corn
Trial No. 1	0.34	0.37	0.36	0.34
Trial No. 2	.34	.338	.36	.38
Trial No. 3	.33	.38	.368	.32
Three-year average	.34	.36	.36	.35

est gaining lot. There was no material difference between the gains of Lot 6 receiving 40 percent corn and Lot 7 receiving 50 percent corn, the 3-year average being 0.36 pound a day in both cases.

Lot 8, receiving a ration of 40 percent hay and 60 percent grain, gained faster than all other lots the second year, but slower the third year and equal to Lot 5 the first year. This lot made an average gain below lots 6 and 7 but above Lot 5 which received the largest proportion of hay.

This difference in gain can be explained by the reaction of the lambs to the greater proportion of grain. Vomiting of lambs was noted in all lots except Lot 5 receiving 70 percent ground hay. In the case of Lot 8 this did not apparently affect the gains greatly until the third year when this lot made the slowest gains of all four lots.

EFFECT ON DRESSED YIELD OF CARCASS

Table 3 shows the hot dressed yield of the lamb carcasses by years and lots, also the average for the three years.

These data indicate a marked increase in dressing percentage in the lots receiving the larger percentage of corn. Corn fed as 30 percent

TABLE 3—*Hot weight dressing percentage by trials and lots*

	Lot 5	Lot 6	Lot 7	Lot 8
	30% Corn	40% Corn	50% Corn	60% Corn
Trial No. 1	45.39	47.89	49.20	48.8
Trial No. 2	47.15	49.17	50.27	50.67
Trial No. 3	44.94	47.19	48.07	49.31
Three-year average	45.84	48.08	49.18	49.68

of the self-fed ration was not sufficient in these trials to produce the finish which will give a high dressed yield. When 40 percent corn was fed in Lot 6 the dressing percentage averaged 2.24 percent above the lot receiving 30 percent corn, but 50 percent corn fed in Lot 7 produced a dressed yield over 1 percent greater than Lot 6. Lot 8 receiving 60 percent corn dressed slightly higher than Lot 7 receiving 50 percent corn. However, the difference between these lots was probably not significant.

PROPORTION OF GRAIN AND DEATH LOSS

The influence of a ration on death loss in feeder lambs is an important consideration. Losses from 1 to 5 percent commonly occur. Losses due to overeating may be controlled by reducing the grain ration. In this test losses were encountered only in the first year. The last two years approximately ½ pound of long hay was fed the first week of the feeding period along with the feed mixture. It is interesting to note that no losses occurred in Lot 5, receiving 30 percent grain and 70 percent hay. Two, four and three lambs died in lots 6, 7, and 8, respectively. This is a 5-percent, 10-percent and 7.5-percent loss for these lots. Deaths of only three of the four lambs lost in Lot 7, and two of the three lambs lost in Lot 8 can be directly attributed to overfeeding as shown by autopsy. These results indicate that lambs fed a mixture as low in grain as Lot 5 are less subject to death loss due to overfeeding.

It should not be overlooked, however, even with a death loss of 5 percent, such as occurred in Lot 6, that the 95 percent lambs remaining would produce more dressed meat (because of greater weight and increased dressing percentage) than all the lambs in Lot 5 with no death losses. In addition, there would be increased value of carcasses due to better finish, a slightly lower feed bill and salvage value of lambs lost.

DISCUSSION

In this experiment the returns were greater in Lot 6 receiving 40 percent corn and having 5 percent death loss than in Lot 5 with no death loss and receiving only 30 percent corn. A ration consisting of 30 percent corn does not produce as satisfactory finish, even though the lambs made good gains in weight.

There was no significant difference among the gains of lots 6, 7 and 8 receiving 40 percent, 50 percent and 60 percent corn. There was, however, a significant difference in dressing percentage of the lambs receiving 50 percent corn compared with those receiving 40 percent corn. The increase in dressing percentage of lambs receiving 60 percent corn over those receiving 50 percent corn is not considered significant.

SUMMARY

1. In these experiments lambs fed 40, 50 and 60 percent cracked corn produced a fatter carcass with a higher dressed yield. They also made equal or faster gains in two out of three years than the lot receiving 30 percent corn.

2. When similar lambs were fed 30 percent cracked corn and 70 percent ground hay they made good gains averaging 0.34 pound daily but lacked finish and dressing percentage.

3. It appears from these tests the desirable proportion of corn in a self-fed ration is somewhere between 40 and 50 percent.

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FARM BUSINESS REPORT FOR 1946

*By N. L. SMITH, E. M. ELWOOD, and J. C. DONETH**

SECTION OF FARM MANAGEMENT

GOOD MANAGEMENT paid dividends on Michigan farms again in 1946. Such is usually the case, although in periods of high prices satisfactory returns can often be obtained without following good management practices. Sound farm organization and management help insure better incomes, especially in years of less favorable price relationships.

The 838 farmers who kept the accounts upon which this report is based are, as a group, above average in both size and quality of business and in efficiency of operation. The results based on these records are, however, indicative of the general success of Michigan farmers during 1946.

PRICES AND COSTS

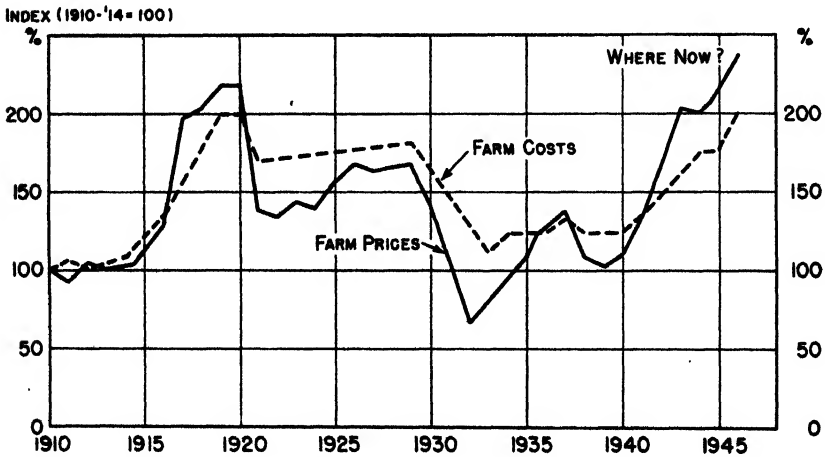

Fig. 1. Michigan farm prices and costs 1910-1946.

*The Farm Management Department of Michigan State College, together with the county agricultural agents and the Michigan Agricultural Experiment Station, again sponsored the extension project in farm accounting. This project has been continuous since 1929. Reports were prepared for each type-of-farming area except 13, based on farm accounts kept in each area.

ARTICLE 30-29

Fig. 2. Types of farming in Michigan.

Average prices received by Michigan farmers in 1946 were 15 percent higher than in 1945. Price increases, although general, did not include all products. Grain, livestock, and dairy product prices averaged higher than in 1945 and increases for these products contributed greatly to the increase in farm incomes over 1945. Prices of alfalfa, apples, and eggs, however, were among those in which decreases were shown.

Prices paid for products used by Michigan farmers increased about 9 percent during the year (this does not include wages which were also higher). The effect of this increase is evident in the increased costs on farms included in this report.

TABLE 1—*Quantity of Michigan farm products needed to pay $100 debt*

Product		1919	1932	1935–39	1945	1946
CROPS						
Corn	Bu.	64	303	145	87	71
Wheat	Bu.	47	233	120	63	53
Potatoes	Bu.	85	357	164	64	74
Beans	Cwt.	14	73	33	16	12
Alfalfa hay	Ton	3.6	12	9.9	4.9	5.5
LIVESTOCK						
Beef cattle (1000 lb.)	No.	1.1	2.5	1.5	.8	.7
Lambs (90 lb.)	No.	8.3	22.2	13.1	8.0	6.6
Hogs (200 lb.)	No.	3.1	13.3	5.8	3.5	2.8
Milk	Cwt.	29	91	58	27*	25*
Butterfat	Lb.	172	552	333	154*	135*
Eggs	Doz.	233	685	474	256	270

*Includes dairy production payments.

The difference in the rates of increase between the prices received and prices paid resulted in a price-cost relationship that continued to be favorable to the farmer. A similar relationship existed during and immediately following the first World War (Fig. 1). Whether it will again reverse itself as it did in 1920 and, if so, when this reversal will take place are questions of prime concern to farmers. If past experience holds true it seems quite likely that prices of farm products will decrease in the near future. This seems likely to occur when the supply of products more nearly meets world needs.

Less of most farm products was needed to provide $100 income in 1946 than in past years (Table 1). This made it an excellent time in which to pay debts contracted in earlier years. Many farmers recognized and took advantage of this situation and are therefore better prepared to face the uncertainties ahead.

FARM EARNINGS

Both incomes and expenses showed increases during 1946 (Table 2). It is significant to note that both are about three times their 1935-39 average and that farm expenses in 1946 were approximately 1½ times larger than the average gross income in the pre-war period.

Labor income, which is the return to the operator of the farm for his labor, management, and business risks incurred during the year averaged $3,374 for the 838 farms. This is $891 higher than 1945. Labor income does not include credit for the use of the farm dwelling or for farm products produced on the farm used by the family.

TABLE 2—*Comparison of gross income, expenses and labor incomes on accounting farms in Michigan, 1935-39 average, and by years 1942-46*

Item	1935–39	1942	1943	1944	1945	1946
INCOME						
Crops and AAA payments	$ 881	$ 1,737	$ 1,684	$ 2,215	$ 1,948	$ 2,641
Dairy products	910	1,605	2,054	2,562	2,782	3,366
Cattle	338	703	624	576	727	894
Hogs	224	648	686	622	538	748
Poultry and eggs	256	492	633	586	744	711
Sheep	112	148	122	102	102	137
Other	161	193	214	212	214	221
Gross income	$ 2,882	$ 5,526	$ 6,017	$ 6,875	$ 7,055	$ 8,718
EXPENSES						
Feed bought	261	590	910	870	889	921
Machinery	291	497	606	717	793	922
Hired labor	231	384	490	635	557	767
Crop expense	193	343	397	498	544	741
Family labor	197	306	390	399	386	418
Improvements	138	168	213	244	247	317
Taxes	74	82	86	96	103	118
Other	56	111	137	165	177	209
Total expense	$ 1,441	$ 2,481	$ 3,229	$ 3,624	$ 3,696	$ 4,413
Net farm income	$ 1,441	$ 3,045	$ 2,788	$ 3,251	$ 3,359	$ 4,305
Interest on investment at 5%	641	742	798	845	876	931
LABOR INCOME	$ 800	$ 2,303	$ 1,990	$ 2,406	$ 2,483	$ 3,374

Although farm income in 1946 was the highest since this project was started in 1929, the long-time returns from farming should be kept in mind before conclusions are made concerning the earning power of farms (Table 3).

FARM INVESTMENTS

Capital investments averaged $18,628 per farm on the farms studied (Table 4). This figure more nearly represents the long-time

TABLE 3—*Farm earnings on farm accounting farms in Michigan, by years, 1929-46*

Year	Labor income	Year	Labor income
1929	$ 585	1938	$ 571
1930	−263	1939	780
1931	−676	1940	787
1932	−595	1941	1,675
1933	249	1942	2,303
1934	565	1943	1,990
1935	764	1944	2,406
1936	1,318	1945	2,483
1937	569	1946	3,374
18-year average			$ 1,049

TABLE 4—*Investments per farm on 838 Michigan farms, 1946*

Item	Investment per farm	Percent of total
REAL ESTATE		
Land	$ 5,977	32
Improvements (less house)	4,591	25
Orchard	488	3
PERSONAL PROPERTY		
Livestock (includes horses)	2,685	14
Machinery and equipment	2,872	15
Feed, crops, and supplies	2,015	11
Total	$18,628	100

productive value of the real estate rather than the present selling price. Feed and livestock are inventoried at more nearly current prices. Approximately two-thirds of the investment is in real estate and one-third in personal property.

VARIATION IN INDIVIDUAL FARM INCOME

Each farm is an individual business. As such, much of its success or failure depends upon the ability of the operator to efficiently organize and operate his business. There is often more difference in income among farms in one type of farming area than there is among the average of farms in different type-of-farming areas.

Many of the factors influencing farming cannot be controlled by the farm operator. However, much of the variation in income among farms within the same type-of-farming areas is due to differences in (1) size of business, (2) type and organization of enterprises on the farm, (3) efficiency in use of labor, power, and machinery, and cropping and soil management practices. These factors can be controlled, at least to some extent, by the farmer if he studies his business and takes advantage of opportunities for improvement.

An analysis of some of the differences among successful and less successful farms has been published in the Farm Business Report for the particular area concerned. No attempt at such analysis is made herein; however, evidence that farms change from one income group to another is shown in Table 5. While this table is an indication of the distribution of labor incomes it is evident that there are many factors which made possible the shift from the lower to the higher income

TABLE 5—*Percentage distribution of labor incomes, by years 1929-46, Michigan*

Year	Total number of farms	Farms in each labor income group		
		$0 or less	$1 to $1,000	$1,001 or more
		Percent	Percent	Percent
1946	838	4	9	87
1945	939	6	17	77
1944	1,031	5	18	77
1943	1,097	8	24	68
1942	1,160	2	18	80
1941	1,041	5	27	68
1940	1,263	12	55	33
1939	1,346	14	54	32
1938	1,252	20	57	23
1937	1,163	22	54	24
1936	1,055	6	43	51
1935	933	13	56	31
1934	845	21	56	23
1933	795	35	55	10
1932	831	87	12	1
1931	925	83	16	1
1930	771	62	32	6
1929	427	23	52	25
18-year average	984	24	36	40

groups. The changes in the general level of farm product prices is probably the primary one. Others are increases in acreage farmed, technological advancements, etc.

SIZE OF BUSINESS

There was comparatively little change from 1945 in the size and intensity of farming operations on the farms keeping records (Table 6). Some of the pressure to produce which was present during the war had been relieved. Farm help continued to be scarce, and many farmers hesitated to expand further without additional labor. In addition, the level of farm income from their present operations was sufficiently high to satisfy most farmers.

TABLE 6—*Comparison of size of farm, amount of livestock and amount of work 1935-39 average and 1942-46 by years, Michigan*

Item	1935-39	1942	1943	1944	1945	1946
Number of farms	1,150	1,160	1,097	1,031	939	838
Total acres	162	176	185	193	195	195
Tillable acres	107	117	122	129	131	133
Productive animal units	20.8	25.6	27.6	27.9	26.5	27.8
Productive man work units	432	464	480	506	490	491
Number of men	1.9	1.8	1.8	1.9	1.7	1.8
Work units per man	227	262	269	286	271	266

CROPS

Crop income averaged $2,641 on Michigan account farms in 1946 (Table 8). This was an increase of $693 from 1945. Crop income includes government payments, crop sales, and any inventory change in feed and crops. Most of the increase shown in 1946 was due to more favorable prices and to improved yields of certain cash crops such as potatoes (especially in commercial potato areas), sugar beets, peaches and sour cherries.

The summer drought in parts of the state reduced the corn yield, damaged new seedings, and made preparations for sowing fall wheat difficult. An early September frost reduced the corn yield considerably and resulted in much corn being cut for silage.

LIVESTOCK

Livestock income averaged $5,856 per farm in 1946. This $963 increase over 1945 was the result of increased prices received for most livestock and livestock products, as well as the increased production rate for at least some classes of livestock.

Higher livestock prices and the more favorable livestock-feed ratios which occurred after the removal of price ceilings improved the position of livestock enterprises on most farms.

Income from livestock made up 67 percent of the gross farm income in 1946, compared with 69 percent a year earlier. This slight decrease in the importance of the livestock contribution is not the result of a decrease in production of livestock or livestock products but is due to increased crop income. Receipts from sale of dairy products were again the most important single source of income. It made up 39 percent of the average gross farm income and 58 percent of the livestock income. Income from cattle constituted 15 percent of the livestock income, hogs 13 percent, poultry and eggs 12 percent, and sheep 2 percent.

FARM EXPENSES

Average expenses per farm on the 838 farms increased from $3,696 in 1945 to $4,413 in 1946. The increase was general and included all items of expense. Higher prices paid for most of the goods and services used in production accounted for much of the increase. Increased

availability of certain items resulted in increased purchases. This was necessary, at least in many cases, since equipment had been worn out during the war years and could not be replaced at the normal rate.

Labor continued to be the largest farm expense, even when operator's wages were charged at or below prevailing hired wage rates. Efficiency in its use is essential for maximum farm income. Improvement of work methods and utilization of simple and economical labor-saving devices can help improve labor efficiency.

Machinery expense was the second highest expense. It is important that farmers carefully consider the amount of use that they will get from a machine before purchasing it. In many cases machinery that can profitably be used cooperatively by several neighboring farmers represents too great an investment and involves too much upkeep to be a wise purchase for use on a small or medium-sized farm.

Purchased feed made up just about as high a percentage of the total expense as did machinery. Better crop yields, better land utilization, and more careful feeding are some practical methods of reducing or controlling this expense item.

The three expenses mentioned above are the "big three" among farm expenses. Farm owners, operators, and managers must be especially careful to see that these particular expenses are kept in line.

Improvement expense is another expense item which should be carefully studied. This is particularly true in the case of farm buildings. New buildings, at present prices, represent a large part of the investment in the farm. Careful consideration of just what a prospective building will add to a farm and a carefully worked out plan of the building design should be accomplished before construction is started. Over-built farms mean useless expense. Carelessly planned farm buildings mean lowered labor efficiency and more hard work.

STATE AND AREA AVERAGES

Farm earnings vary annually depending on prices and costs, weather, etc., and their effect upon farm income in various sections of the state. A comparison of investments, income, expenses, and crop and livestock enterprises by type-of-farming areas appears in tables 7, 8, 9, and 10.

TABLE 7—*Financial summary of 838 Michigan farms by type-of-farming areas, 1946*

Type-of-farming areas	All farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	838	96	73	24	42	133	40	20	91	33	65	29	52	33	21	21	61
Total acres	195	193	221	110	167	209	196	229	169	186	211	167	203	234	217	192	184
Percent of farm acres tillable	68	74	78	80	77	77	78	84	78	54	60	66	60	49	65	47	36
Tillable acres	133	146	173	89	128	130	152	192	132	101	125	111	122	114	140	90	66
Real estate (less house)	$11,056	$12,590	$12,376	$17,748	$11,078	$12,808	$13,681	$14,095	$13,852	$ 6,988	$ 8,881	$15,457	$ 6,499	$ 6,748	$ 6,495	$ 7,681	$ 5,007
Machinery and equipment	2,872	3,068	2,879	3,249	3,139	3,112	3,193	3,141	3,234	1,931	2,805	4,110	2,472	1,892	2,169	2,551	2,037
Livestock (includes horses)	2,685	3,582	2,895	1,268	3,035	3,451	3,213	3,693	2,605	2,557	2,482	1,416	1,777	1,825	1,827	2,201	1,667
Feed and crops	2,015	3,045	2,452	999	2,225	2,821	2,383	1,935	2,335	969	1,654	1,333	1,425	909	976	1,061	714
Capital investment, total	$18,628	$22,285	$20,602	$23,234	$19,477	$22,192	$22,450	$22,897	$22,033	$12,445	$15,822	$22,316	$12,173	$11,374	$11,467	$13,504	$ 9,455
Livestock income	$ 5,856	$ 7,869	$ 6,858	$ 2,421	$ 8,042	$ 7,171	$ 6,678	$ 6,512	$ 5,792	$ 4,225	$ 5,574	$ 2,866	$ 3,549	$ 3,767	$ 3,528	$ 5,846	$ 4,276
Crop income	2,641	2,063	1,723	11,346	1,247	1,574	2,610	2,781	3,950	1,163	1,884	14,766	1,930	1,251	1,558	873	785
Other income	221	227	174	183	162	226	222	301	186	206	197	161	167	238	340	198	397
Gross income	$ 8,718	$10,150	$ 8,755	$13,950	$ 9,451	$ 8,971	$ 9,510	$ 9,594	$ 9,928	$ 5,594	$ 7,655	$17,793	$ 5,646	$ 5,256	$ 5,426	$ 6,917	$ 5,458
Total expenses*	4,413	4,699	4,555	8,408	5,466	4,549	5,400	4,864	4,414	2,483	4,379	9,042	2,817	2,622	2,586	3,288	2,629
Net farm income	$ 4,305	$ 5,451	$ 4,200	$ 5,542	$ 3,985	$ 4,422	$ 4,110	$ 4,730	$ 5,514	$ 3,111	$ 3,276	$ 8,751	$ 2,829	$ 2,634	$ 2,840	$ 3,629	$ 2,829
Less: interest at 5%	931	1,114	1,031	1,164	974	1,110	1,122	1,145	1,101	622	791	1,116	608	568	573	675	472
Labor income 1946	$ 3,374	$ 4,337	$ 3,169	$ 4,378	$ 3,011	$ 3,312	$ 2,988	$ 3,585	$ 4,413	$ 2,489	$ 2,485	$ 7,635	$ 2,221	$ 2,066	$ 2,267	$ 2,954	$ 2,357
Labor income 1945	2,483	3,432	2,464	1,434	2,710	3,228	2,807	2,181	2,978	1,514	2,226	2,667	1,554	1,613	1,345	1,766	1,653
Labor income 1944	2,406	2,719	1,452	3,536	2,409	2,496	2,712	2,753	2,940	1,815	2,393	5,831	1,819	1,613	1,661	1,850	1,551
Labor income 1943	1,990	2,235	2,473	4,475	2,101	2,222	2,378	1,502	2,272	929	1,704	3,590	1,380	1,098	670	1,683	1,080
Labor income 1942	2,303	3,056	2,389	2,637	2,142	2,763	2,856	2,673	2,543	1,636	2,330	2,806	1,489	1,253	1,346	1,601	1,193

*Includes family labor but not operator's labor or interest on investment.

TABLE 8—*Kinds of crops and percentage of tillable land in different crops and also yields by type-of-farming areas in Michigan, 1946*

Type-of-farming areas	All farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	838	96	73	24	42	136	40	20	91	33	66	29	52	33	21	21	61
Number of tillable acres	133	146	173	89	128	160	152	192	132	101	126	111	122	114	140	90	66
Percent in sod crops	44	37	41	24	38	36	45	52	32	50	51	34	54	62	60	60	67
Percent in legumes	27	26	31	14	25	28	29	15	23	29	33	21	24	33	22	43	28
Percent tillable acres in:																	
Tillable pasture	19	15	20	7	13	16	22	26	13	20	22	13	23	29	17	17	11
Alfalfa hay	11	12	10	11	10	11	11	11	11	11	12	5	10	18	2	19	6
Other hay	14	10	11	6	15	9	12	15	8	19	17	16	21	15	41	24	50
Corn (includes corn silage)	18	28	24	12	23	23	17	8	18	14	16	10	13	4	1	11	1
Wheat	8	10	11	3	11	11	6	5	8	7	4	3	2	5	2	2	1
Oats and oat mixtures	15	17	13	7	18	17	15	15	14	15	13	8	11	8	11	17	17
Barley	2	1	—	—	2	1	2	1	4	2	—	—	1	4	3	3	2
Beans	3	—	—	—	—	3	4	9	14	6	1	—	—	—	—	—	—
Sugar beets	1	—	—	—	—	—	2	5	—	1	—	—	—	—	—	—	—
Potatoes	1	—	—	—	—	—	1	—	5	—	5	1	6	3	—	4	4
Fruit and truck	3	—	—	49	3	—	4	—	—	—	—	36	—	—	—	—	—
Other crops	5	6	9	5	3	7	2	4	5	5	7	5	10	11	23	3	4
Idle	—	1	2	—	2	2	2	1	—	—	3	3	3	3	—	—	4
Crop yields per acre:																	
Alfalfa hay	1.6	1.7	1.4	1.7	1.7	1.8	1.8	1.9	1 7	1.5	1.7	1.7	1.6	1 4	1.9	1.8	1.7
Other hay	1.3	1.3	1.2	1 3	1.4	1.3	1.5	1 6	1.3	1 2	1.2	1 0	1.4	1.4	1.6	1.7	1.3
Corn for silage	6.0	—	—	7 3	5.4	—	—	6.8	—	—	—	6 6	4.8	—	—	7.6	—
Corn (shelled)	32	39	30	37	26	23	35	54	42	35	27	26	27	9	—	—	7
Wheat	28	30	24	30	27	28	31	30	31	27	28	24	24	26	21	21	23
Oats	50	54	47	54	53	52	53	47	55	50	42	55	39	38	34	61	45
Barley	36	29	—	—	22	36	36	31	44	43	—	—	46	30	26	45	31
Beans	15	—	—	—	—	13	11	10	18	9	11	—	—	—	—	—	—
Potatoes	174	—	—	—	—	—	141	—	—	—	169	191	191	208	—	217	220
Sugar beets	9.0	—	—	—	—	—	7.1	8.0	10.0	8.1	—	—	—	—	—	—	—
Crop yield index	100	113	96	108	98	95	105	104	119	95	92	94	125	92	104	120	117
Crop sales and AAA payments	$ 2,368	$ 1,801	$ 1,613	$10,731	$ 1,236	$ 1,626	$ 2,364	$ 2,376	$ 3,436	$ 960	$ 1,657	$ 1,260	$ 1,723	$ 931	$ 1,231	$ 736	$ 635
Crop income, total	2,641	2,063	1,723	11,346	1,247	1,574	2,610	2,781	3,950	1,163	1,884	14,766	1.930	1,251	1,558	873	785
Feed bought	921	1,244	1,079	706	1,790	1,069	727	889	825	411	1,080	576	475	554	516	803	691

TABLE 9—*Livestock: Kinds, amounts, and returns from livestock by type-of-farming areas in Michigan, 1946*

Type-of-farming areas	All farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	838	96	73	24	42	136	40	20	91	33	66	29	52	33	21	21	61
Livestock income, total	$ 5,856	$ 7,860	$ 6,856	$ 2,421	$ 8,042	$ 7,172	$ 6,678	$ 6,512	$ 5,792	$ 4,225	$ 5,574	$ 2,866	$ 3,549	$ 3,767	$ 3,528	$ 5,856	$ 4,276
Livestock income per T.A.*	43.89	53.81	39.51	27.26	62.74	44.71	44.02	33.84	43.76	41.98	44.33	25.72	29.07	33.10	25.27	65.41	64.31
Productive animal units	27.8	37.5	36.7	10.7	28.7	33.2	27.6	30.3	27.5	25.6	26.1	13.6	20.8	22.8	18.6	24.3	19.0
Tillable acres per PAU**	4.8	3.9	4.7	4.2	4.5	4.8	5.5	6.3	4.8	3.9	4.8	8.2	5.9	5.0	7.5	3.7	3.5
Cattle:																	
Percent of farms reporting	99	99	99	92	100	99	100	100	100	100	100	97	100	100	100	100	100
Cows per farm reporting	12.8	11.6	14.0	5.7	15.9	14.1	15.6	18.5	11.9	10.2	13.0	7.7	11.7	11.4	10.3	16.9	13.5
Dairy sales per cow	$ 267	$ 289	$ 269	$ 283	$ 297	$ 288	$ 301	$ 295	$ 278	$ 194	$ 247	$ 229	$ 200	$ 188	$ 185	$ 288	$ 265
Dairy sales per farm reporting	3,496	3,397	3,651	1,864	4,731	4,095	4,935	5,448	3,357	2,044	3,210	2,341	2,337	2,145	1,902	4,880	3,635
Income per farm reporting	890	1,253	857	333	849	1,068	1,119	1,313	932	1,327	739	586	600	861	698	672	445
Hogs:																	
Percent of farms reporting	72	86	78	54	50	57	35	30	54	61	42	24	52	39	33	48	34
Sows per farm reporting	3.2	4.5	5.0	2.0	1.2	3.6	1.6	1.0	3.2	1.6	2.3	1.2	1.7	1.5	1.3	1.5	1.4
Litters farrowed per farm	5.6	8.3	9.4	1.0	2.3	6.0	2.8	1.5	2.9	1.5	1.8	1.9	2.9	2.0	2.0	3.0	1.5
Pigs weaned per litter	6.5	6.4	6.2	6.3	6.5	6.5	6.2	7.3	6.6	7.5	6.8	7.7	6.8	7.0	7.0	6.6	5.2
Income per farm reporting	$ 1,032	$ 2,207	$ 2,233	$ 485	$ 497	$ 1,008	$ 507	$ 136	$ 1,054	$ 548	$ 790	$ 347	$ 359	$ 260	$ 173	$ 39	$ 31
Sheep:																	
Percent of farms reporting	19	26	23	—	24	29	10	20	10	18	9	—	8	33	14	10	2
Ewes per farm reporting	38	44	51	—	25	40	53	16	32	29	39	—	23	34	22	9	—
Lambs raised per 100 ewes	100	95	101	—	96	100	98	105	114	84	98	—	54	111	132	—	—
Income per farm reporting	$ 717	$ 945	$ 917	—	$ 450	$ 1,002	$ 783	$ 215	$ 659	$ 443	$ 744	—	$ 82	$ 707	$ 541	$ 219	$ 11
Poultry:																	
Percent of farms reporting	81	89	85	83	95	84	85	85	87	85	76	69	67	97	95	71	54
Hens per farm reporting	133	166	117	91	324	125	118	73	157	91	150	107	68	64	110	82	91
Egg sales per hen	$ 4.62	$ 4.67	$ 4.28	$ 4.26	$ 5.29	$ 4.67	$ 4.34	$ 3.78	$ 3.96	$ 3.72	$ 5.38	$ 5.23	$ 3.76	$ 3.65	$ 5.54	$ 4.52	$ 5.00
Egg sales per farm reporting	670	773	537	433	1,756	628	526	296	629	338	881	621	330	275	719	556	499
Income per farm reporting	265	443	242	28	602	298	139	−11	167	180	559	124	188	70	152	41	94

*T.A.=Tillable acres. **PAU=Productive animal units.

TABLE 10—*Expense and efficiency factors: Labor, machinery, improvements, and other costs by type-of-farming areas in Michigan, 1946*

Type-of-farming areas	All farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	838	96	73	24	42	136	40	20	91	33	66	29	52	33	21	21	61
Gross income per tillable acre	$ 65.39	$ 69.50	$ 50.46	$157.07	$ 74.34	$ 56.09	$ 62.71	$ 49.86	$ 75.01	$ 55.57	$ 60.88	$159.00	$ 46.25	$ 26.16	$ 38.84	$ 77.28	$ 82.09
Total expenses per tillable acre*	41.10	39.86	33.00	107.49	51.67	35.57	42.38	31.00	42.00	33.98	43.31	90.25	30.71	31.01	25.25	47.46	52.76
Total expenses*	5,480	5,821	5,725	9,546	6,623	5,688	6,427	5,964	5,559	3,421	5,445	10,057	3,748	3,530	3,527	4,248	3,509
Man labor:																	
Number of men	1.8	1.7	1.7	2.8	2.0	1.7	2.2	2.0	1.8	1.7	1.8	3.4	1.6	1.7	1.6	1.7	1.7
Work units per man	284	332	325	—	284	323	257	305	285	244	265	—	264	220	216	256	209
Hired labor	$ 767	$ 498	$ 503	$ 3,214	$ 869	$ 483	$ 1,539	$ 795	$ 620	$ 230	$ 666	$ 3,999	$ 428	$ 411	$ 370	$ 649	$ 330
Family labor	418	410	408	249	418	438	408	560	481	470	456	489	273	325	351	268	481
Operator's labor	1,067	1,122	1,170	1,138	1,157	1,139	1,027	1,100	1,145	938	1,066	1,015	931	908	941	960	880
Man labor cost per tillable acre	16.89	13.90	12.00	51.81	19.06	12.91	19.61	12.76	16.97	16.27	17.39	49.38	13.38	14.44	11.90	20.98	25.43
Power and machinery:																	
Percent without horses	41	50	42	38	29	40	33	15	53	24	27	59	27	30	14	14	51
Investments	$ 2,872	$ 3,068	$ 2,879	$ 3,249	$ 3,139	$ 3,112	$ 3,193	$ 3,141	$ 3,234	$ 1,931	$ 2,805	$ 4,110	$ 2,472	$ 1,892	$ 2,169	$ 2,561	$ 2,067
Annual expense	922	995	999	1,170	888	995	1,047	1,087	1,098	638	856	1,457	728	620	669	740	536
Expense per tillable acre	6.92	6.81	5.76	13.18	6.92	6.22	6.90	5.65	8.29	6.33	6.81	13.08	5.97	5.45	4.79	8.27	8.06
Improvements:																	
Investment (less house)	$ 4,591	$ 5,632	$ 4,952	$ 4,858	$ 4,827	$ 5,488	$ 5,836	$ 5,840	$ 5,721	$ 2,619	$ 4,059	$ 4,952	$ 2,758	$ 2,836	$ 2,511	$ 3,279	$ 2,490
Investment per animal unit	157	147	131	406	160	160	200	181	201	97	129	358	124	116	123	128	126
Annual expense	317	406	333	374	313	419	348	345	394	185	286	342	172	188	141	192	153
Expense per tillable acre	2.38	2.78	1.92	4.21	2.44	2.62	2.29	1.79	2.98	1.84	2.28	3.07	1.41	1.65	1.01	2.15	2.30
Feed bought, total	$ 921	$ 1,244	$ 1,079	$ 702	$ 1,790	$ 1,069	$ 727	$ 889	$ 825	$ 411	$ 1,080	$ 576	$ 475	$ 554	$ 516	$ 803	$ 691
Per tillable acre	6.91	8.52	6.22	7.90	13.97	6.68	4.79	4.62	6.23	4.08	8.59	5.17	3.89	4.87	3.69	8.97	10.40
Crop expense, total	$ 741	$ 783	$ 854	$ 2,265	$ 785	$ 741	$ 897	$ 728	$ 646	$ 370	$ 729	$ 1,819	$ 554	$ 343	$ 361	$ 369	$ 287
Per tillable acre	5.56	5.36	4.92	25.51	6.13	4.63	5.91	3.79	4.88	3.68	5.80	16.32	4.54	3.01	2.58	4.11	4.32
Taxes, total	$ 118	$ 138	$ 149	$ 119	$ 129	$ 154	$ 166	$ 189	$ 142	$ 69	$ 85	$ 114	$ 70	$ 58	$ 58	$ 76	$ 39
Per tillable acre	.88	.95	.86	1.34	1.01	96	1.10	.98	1.07	.69	.67	1.02	.57	.51	42	.84	.59
Other expense, total	$ 209	$ 225	$ 230	$ 315	$ 274	$ 250	$ 268	$ 271	$ 208	$ 110	$ 221	$ 246	$ 117	$ 123	$ 120	$ 191	$ 112
Per tillable acre	1.56	1.54	1.32	3.54	2.14	1.55	1.78	1.41	1.58	1.09	1.77	2.21	95	1.08	.86	2.14	1.66

*Includes operator's and family labor but not interest on investment.

PRELIMINARY REPORT ON FIELD APPLICATIONS OF ISOPROPYL-PHENYLCARBAMATE IN THE CONTROL OF QUACK GRASS IN AN ESTABLISHED SOD

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THE SELECTIVE inhibitory action of isopropyl-phenylcarbamate upon cereals and certain crop plants has been variously demonstrated (1, 4, 5, 6, 8). Greenhouse tests indicate that in applications to the soil the material prevents the sprouting of buds on mature quack grass rhizomes at rates as low as 6 pounds per acre, area basis (2), and kills quack grass seedlings at rates as low as 2 pounds per acre (3).

The present work essays to determine the effectiveness of isopropyl-phenylcarbamate in field applications on a two-year-old quack grass sod, using equipment and methods of application available to many farmers.

EXPERIMENT 1

In order to bracket the minimum effective concentration indicated by the greenhouse work, 5 and 10 pounds per acre of isopropyl-phenylcarbamate were selected as basic applications. Each spray application was made in 25 gallons of water per 1/27A plot, using "Dreft" as a wetting agent. Each plot was gone over once with a field cultivator before and after each application to expose a maximum of rhizomes to the spray and to promote additional mixing of the material with the surface soil. The schedule of cultivations, dusting and spraying is outlined in Table 1. A gravity-type spray rig with no provision for agitation was used, and with which difficulty was experienced keeping the IPC in suspension. The dust applications were put on by hand, with similar before-and-after cultivations. The single applications received a summer fallow identical to the check.

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ARTICLE 30-30

TABLE 1—*Effect of early summer applications of isopropyl-phenylcarbamate as a spray in aqueous suspension and as a 5 percent dust with talc as a diluent on the stand of quack grass (Agropyron Repens) in a two-year-old sod.*

Applications worked in with a field cultivator.
Estimates of stand made 76 days after initial application, 30 days after final application (check = 100).
1/27-acre plots, in duplicate.

Treatment No.	Treatment	Schedule of treatments										Total		Estimated stand Aug. 8
	Date	5/23	5/24	5/31	6/9	6/11	6/18	6/28	7/2	7/3	7/8	Field cultivations	Lb./A. IPC	
1	Number of field cultivations	1	1	1	1	1		1	1			7		
	Pounds per acre IPC as spray		5										5	100
2	Number of field cultivations	1	1		1	1			1			5		
	Pounds per acre IPC as a spray		5			5							10	100
3	Number of field cultivations	1	1		1	1			1	1		6		
	Pounds per acre IPC as a spray		5			5			5				15	70
4	Number of field cultivations	1	1	1	1	1		1	1			7		
	Pounds per acre IPC as a spray		10										10	100
5	Number of field cultivations	1	1		1	1			1			5		
	Pounds per acre IPC as a spray		10			10							20	100
6	Number of field cultivations	1	1		1	1			1	1		6		
	Pounds per acre IPC as a spray		10			10			10				30	70
* 7	Number of field cultivations	1	1	1	1	1		1	1		2	9		
	Pounds per acre IPC as a dust		5				5				5		15	70
* 8	Number of field cultivations	1	1	1	1	1		1	1			7		
	Pounds per acre IPC as a dust		5										5	100
9	Number of field cultivations	1	1	1	1	1		1	1			7		
	Check												Ck.	100

*Not replicated.

The results are given in Table 1. Recovery of quack grass after summer fallow operations were terminated (July 8) was so vigorous on all plots that no accurate counts were made of the stand. The only plots showing significant reduction in stand were those on which the basic applications had been repeated three times. These stands were estimated to have been reduced by approximately 30 percent, regardless of whether the basic rate was 5 or 10 pounds, or whether spray or dust were used. It is possible that this greater effectiveness may have resulted from a combination of more complete contact with the mass of rhizomes and the maintenance of an effective concentration of the material in the soil over a longer period.

At the time of the first field cultivation, numerous new rhizomes up to ½-inch in length were observed to be forming throughout the plot area. The growing points of these were observed to continue in their growth during the period of treatment, except as injured by actual exposure to desiccation. They contributed largely to the regenerated stand. Conversely, rhizomes, whose buds were dormant and exposed at the time of the second application (June 11) formed chlorophyll but no shoots in the following three weeks. This was in spite of the fact that during this period 3 inches of rain fell on nine scattered days of precipitation, and very few rhizomes were injured by desiccation.

Several factors might have contributed to the relative ineffectiveness of these early summer applications: 1. A large number of buds had sprouted before contact was made with them (the sheath points apparently protect the meristematic tissues from the effect of the material); 2. The attempt to work the IPC into the surface soil with a minimum of tillage operations resulted in turning up numerous clods or turfs which were not subject to penetration by the material, and 3. Isopropyl-phenylcarbamate may have been inactivated by bacterial action in the soil (3, 5). Repeated workings of the surface soil as employed in this experiment would have tended to increase the rate of this bacterial decomposition.

EXPERIMENT 2

It seemed advisable, in the light of the experience with the first experiment, to compare surface applications with varying degrees of incorporation, over a wider range of rates of application, and at a time of year when there would be a minimum of growing points, or a maximum of dormant buds in the soil.

TABLE 2—*Effect of mid-summer applications of IPC as a spray in aqueous suspension and as a dust on the stand of quack grass (Agropyron Repens) in a two-year-old sod. Hay cut July 10.*

Block 1—"Ripped up" with field cultivator 5 times July 16—to depth of 4".
Block 2—Plowed to depth of 10" and field cultivated 5 times July 16—to depth of 4".
1/27-acre plots, not replicated.

Treatment No.	Schedule of treatments										Block 1		Block 2		Treatment No.
	First application			Additional treatment	Second application			Additional treatment	Total treatment		Surface counts: new crowns/sq. ft. Sept. 20		Surface counts: new crowns/sq. ft. Sept. 20		
	Pounds per acre IPC	Form of application	Date of application		Pounds per acre IPC	Form of application	Date of application		Pounds per acre IPC	No. of field cultivations	Range of counts	Average of 10 counts	Range of counts	Average of 10 counts	
1	10	*Dust	7/21	Field cultivated 2 times immediately after IPC applications.	10	*Dust	8/16	Field cultivated 4 times immediately after IPC applications.	20	6	1–20	6	0–10	4	1
2	20	*Dust	7/21		20	*Dust	8/16		40	6	1–8	4	1–9	4	2
3	30	*Dust	7/21		30	*Dust	8/16		60	6	0–14	5	0–10	4	3
4	None				Field cultivated 4 times at 5 to 10 day intervals through 8/18.				None	6	3–15	10	1–11	6	4
5	10	*Dust	7/21						10	2	2–16	8	5–17	11	5
6	20	*Dust	7/21						20	2	1–18	6	2–14	6	6
7	30	*Dust	7/21						30	2	0–7	3	0–8	3	7
8	None								None	2	4–21	13	6–25	12	8
9	‡ 10	**Spray	7/19	Compacted under wheels of spray rig.					10	None	No count		4–16	9	9
10	‡ 20	**Spray	7/19						20	None	No count		0–5	2	10
11	‡ 30	**Spray	7/19						30	None	No count		0–2	1	11
12	10	**Spray	7/19						10	None	8–21	14	10–42	20	12
13	20	**Spray	7/19						20	None	8–16	11	3–19	9	13
14	30	**Spray	7/19						30	None	2–16	8	0–14	4	14
15	† 30	**Spray	7/19	Spray applied on undisturbed sod with no additional treatment.					30	None	6–15	12			15
16	None	Undisturbed sod.							None	None	50–131	72			16

*1:1 Mixture of sand and hydrated lime used as diluent. First application by hand. Second application with grain drill calibrated to deliver 100 pounds per acre of the diluent; plot treatments secured by varying dilution.
†Area covered by treatment: 64 sq. ft.

**Each plot treatment applied in 25 gallons of water with medium pressure orchard spray rig using ordinary conical spray nozzle. Dreft used as wetting agent. Mechanical agitator employed to keep material in suspension.
‡Area covered by treatment: 100 sq. ft.

TABLE 3—*Effect of mid-summer applications of isopropyl-phenylcarbamate as a dust thoroughly mixed into the surface 6 inches of soil on the stand of quack grass (Agropyron Repens) in a two-year-old sod. Hay cut July 10.*

Block 3—Field cultivated 5 times July 16, to depth of 4 inches. Block 4—Plowed to depth of 10 inches and field cultivated 5 times July 16, to depth of 4 inches.
1/27-acre plots, not replicated.

Schedule of treatments				Block 3		Block 4	
				Surface count: new crowns/sq. ft. Sept. 20		Surface count: new crowns/sq. ft. Sept. 20	
Treatment number	Date of application	Lb./acre *IPC (dust)	Number of field cultivations	Range of counts	Average of 10 counts	Range of counts	Average of 10 counts
17	7/31	None	10 times over immediately after dust.	11–31	21	12–36	24
18	7/31	5	Applications—to depth of 6 inches.	3–13	7	1–17	8
19	7/31	10	Applications—to depth of 6 inches.	0–8	2	2–17	7
20	7/31	20	Applications—to depth of 6 inches.	0–13	3	0–6	4
21	7/31	30	Applications—to depth of 6 inches.	0–5	2	0–9	3
22	7/31	None	6:–3 Double coverages at 9-day intervals thru Aug. 18.	3–16	7	6–27	17

*Dust applied with grain drill calibrated to deliver 100 pounds per acre of a 1:1 mixture of sand and hydrated lime, which was used as a diluent. Plot treatments were secured by varying dilution.

Four blocks were laid out on a two-year-old quack grass sod containing a scattering of alfalfa. The hay crop was cut July 10. Two blocks were plowed to a depth of 8 to 10 inches on July 16. All four blocks were field-cultivated, five times the same day, beginning at a depth of one-half inch the first time over, going progressively deeper to 4 inches the last time over. This preliminary treatment was designed to open the sod and eliminate the clod formation encountered in the first experiment.

Isopropyl-phenylcarbamate treatments were applied according to the schedule of treatments listed in tables 2 and 3, in which the results are also given.

Treatments 9, 10, and 11 designate only the wheel tracks of the spray rig used to apply the spray treatments 12, 13 and 14 on Block 2. The results cannot be explained by any coincidence of factors other than those of the treatment, and they are striking enough to justify their inclusion in a report on work of the roughly exploratory nature herein described.

Treatment 15 designates a circular area 9 feet in diameter included in the plot covered by treatment 14, Block 1. It was covered by a

hay tripod at the time of the preliminary field cultivation and so was not worked before the application of the spray. Here again, the results are indicative of one of the potentialities of isopropyl-phenylcarbamate and are included in this report.

DISCUSSION OF TABLES 2 AND 3

From comparison of the surface stand of new crowns on treatments 4, 8, 17, and 22, with the stand in the undisturbed sod, treatment 16, it will be seen that the summer fallow operations alone reduced the stand by 70 to 90 percent.

Where a minimum of incorporation with the soil was accomplished or none at all was done, the additional reduction in stand attributable to the isopropyl-phenylcarbamate is proportional to the rate of application at rates of 10, 20 and 30 pounds per acre. No additional reduction in stand resulted from 40- and 60-pound applications.

Where thorough mixing with the soil was accomplished, the effect of the isopropyl-phenylcarbamate leveled off at 10 pounds per acre.

In no case where the growth regulator was worked into the soil was the reduction in stand attributable to the chemical greater than 30 percent compared with the undisturbed sod. This reduction occurred at the level of 30 pounds per acre, with thorough mixing after deep plowing (treatment 21, Block 4). With thorough mixing into the sod following preliminary field cultivation only, a reduction of 25 percent was secured by application of 10 pounds per acre or more (again compared with the undisturbed sod).

There was no check to indicate the relative effectiveness of the single summer fallow operation included in treatments 9 through 14. It will be observed, however, that the surface spray which was not mixed into the soil (treatments 12, 13, 14) was not so effective as the equivalent treatments worked into the soil on the plots receiving dust treatments 5, 6, and 7. Where the ground was compacted following the spray (treatments 9, 10, 11), the effectiveness was increased to the point where 10 pounds per acre of IPC was almost equivalent to 20 pounds worked into the soil and 20 pounds per acre was equal to 30 pounds worked in, whereas 30 pounds per acre followed by compaction resulted in almost complete elimination of top growth.

It is possible that part of the observed inhibition may have been the result of physical impedance to shoot growth owing to extreme compaction of a relatively thick layer of soil above the mass of rhizomes at the bottom of the furrow slice. The same result was not secured where the compaction occurred on the sod in Block 1, which had been gone over five times with the field cultivator but had not been plowed.

However, that the isopropyl-phenylcarbamate was a factor is evidenced by the inverse proportionality of stand to rate of application on these three plots. The compacted strips were at right angles to the furrows, so that coincidence of the wheel tracks with relatively deeper or shallower portions of the furrow slice is ruled out.

The spray application on the undisturbed sod (treatment 15) was followed by 0.32 inch of rain during the ensuing 36 hours. Theoretically, with a solubility of IPC of 250 ppm. (1), slightly more than 30 pounds an acre of the material could have been dissolved in this amount of water, and possibly a good proportion of the application was washed into the soil.

Twenty days after treatment, the recovery on this small area was limited to a few scattered spindling spears of grass, whereas the adjacent untreated sod had a lush growth 4 to 6 inches high.

On September 20, 63 days after treatment, some recovery had been made, but the stand was still only 20 percent of that on adjacent sod areas, and the height of the grass was 3 inches as compared with 12 inches where untreated. The alfalfa in the original stand appeared normal and grew luxuriantly.

DISCUSSION OF TABLES 4 AND 5

In an effort to uncover some of the below-ground relationships contributing to the variations in surface stand, cube samples of the surface soil and included plant materials, one foot on a side, were taken for examination from a number of plots which had undergone contrasting extremes of treatment. These observations are tabulated, with a summary of treatments, in tables 4 and 5.

It will be seen from the total weights of plant material removed per cubic foot of surface soil that there were wide variations in the original stands over the plots. Obviously a single sample per plot cannot be highly significant. However, certain general relationships are of interest.

TABLE 4—*Effect of mid-summer applications of isopropyl-phenylcarbamate and summer fallow operations on the proportionate vegetative composition of a two-year-old quack grass sod. A single determination per plot. 1/27-acre plots, not replicated.*

Treatment number	Treatment summary: Preliminary treatment	Lb./acre IPC	Number of additional field cultivations	Total effective summer fallow operations*	Grams total plant material per cu. ft. of surface soil	Percent tops	Grams total underground parts	Percent dead rhizomes	Percent old viable rhizomes	Percent new rhizomes **
Block 1– 3	Field cultivated only	60 (dust)	6	3	48	3.7	46	74.2	23.6	2.2
Block 4	Field cultivated only	None	6	6	28	11.1	25	67.6	23.6	8.8
Block 7	Field cultivated only	30 (dust)	2	2	23	18.2	19	56.1	35.6	8.3
Block 8	Field cultivated only	None	2	2	45	27.8	32	34.2	34.5	31.3
Block 2– 3	Plowed and field cultivated	60 (dust)	6	3	29	5.2	28	65.0	29.3	5.7
Block 4	Plowed and field cultivated	None	6	6	36	13.8	31	21.4	49.1	29.5
Block 7	Plowed and field cultivated	30 (dust)	2	2	39	1.3	39	13.3	75.9	10.8
Block 8	Plowed and field cultivated	None	2	2	75	21.2	59	12.3	53.9	33.8
Block 11	Plowed and field cultivated†	30 (spray)	None	1 (compacted)	36	0.0	36	32.0	62.0	6.0
Block 3–17	Field cultivated only	None	10	2	40	33.1	27	42.8	25.8	31.4
Block 18	Field cultivated only	5 (dust)	10	2	31	15.4	26	60.8	31.3	7.9
Block 20	Field cultivated only	20 (dust)	10	2	19	4.0	18	57.4	40.7	1.9
Block 21	Field cultivated only	30 (dust)	10	2	36	11.1	33	46.6	37.0	16.4
Block 22	Field cultivated only	None	6	4	22	10.1	20	64.3	31.2	4.5
Block 4–17	Plowed and field cultivated	None	10	2	64	27.5	46	15.4	59.8	24.8
Block 18	Plowed and field cultivated	5 (dust)	10	2	46	27.7	33	13.7	50.5	35.8
Block 20	Plowed and field cultivated	20 (dust)	10	2	30	12.6	26	2.2	70.1	27.7
Block 21	Plowed and field cultivated	30 (dust)	10	2	21	13.6	18	8.7	68.0	23.3
Block 22	Plowed and field cultivated	None	6	4	42	17.1	35	11.0	70.0	19.0
Block 1–15	None‡	30 (spray)	None	None	49	4.7	47	0.6	86.0	13.2
Block 16	None‡	None	None	None	104	35.6	64	0.3	82.5	17.2

*All tillage operations completed within the same working day lumped together as "single effective summer fallow operation." Based on assumption that effectiveness of summer fallow on quack grass, employing surface tillage with a field cultivator, depends on an interim of at least a day with ideal drying conditions between successive operations for thorough desiccation of exposed rhizomes.

**Growth since removal of hay crop, as evidenced by color of rhizomes and leaf scales, vigor, and orientation with respect to new crowns, residual stubble-crowns, and plowed-under segments of the original sod.

†Area covered by treatment: 100 sq. ft.

‡Area covered by treatment: 64 sq. ft.

Very few dead rhizomes were found in the undisturbed sod, whether treated or untreated. Exposure and desiccation were necessary for an actual kill. However, desiccation and IPC apparently had a cumulative effect in killing rhizomes. Except for the treatments on Block 4, all IPC plots showed a greater percentage of dead rhizomes than did the checks with comparable summer fallow treatments.

The percentage of new rhizomes was greatly increased by limited summer fallow alone (less than three effective summer fallow operations). At 30 pounds per acre, where worked in a minimum number of times, and at 5 pounds per acre, where thoroughly incorporated into the upright sod, IPC greatly reduced the percentage of new rhizomes.

TABLE 5—*Effect of mid-summer applications of isopropyl-phenylcarbamate on the regenerative bud population and on the depth of origin of new crowns in a two-year-old quack grass sod, two months after application.*

Summary of treatments same as in Table 4.

Treatment number	Growing points/cu ft. of surface soil		Depth of origin of new crowns		
			Depth to parent stubble—crown or rhizome		Number of new crowns per count
	Total	Showing percent injury*	Range (inches)	Average (inches)	
Block 1– 3	52	71	1– 3	2¾	15
Block 4	44	77	¼– 5	1½	15
Block 7	21	62	1– 3	2	9
Block 8	45	31	¼– 4	1½	45
Block 2–11	12	0	1½– 6	2¾	** 19
Block 3–17	81	42	½– 7	3¼	46
Block 18	61	75	2– 4	3¼	19
Block 20	16	100	1– 5	3	9
Block 21	91	59	4– 8	6	5
Block 22	32	44	¼– 2	½	21
Block 4–17	105	59	¼–10	4½	42
Block 18	155	74	1– 7	4½	36
Block 20	132	62	5–10	7	11
Block 21	97	73	3– 9	6	8
Block 22	91	59	½–10	7½	14
Block 1–15	95	50	1¾–2¾	2¼	** 22
Block 1–16	57	4	¼– 5	2	131

*Injury apparently due to nematodes and wireworms observed working on injured sheath-points.
**Not limited to 1 sq. ft. area.

The percentage of new rhizomes bears no consistent relationship to the percentage of top growth. In some cases, it is evident that considerable new rhizome growth has occurred under the most reduced surface stands, and that a marked increase in surface stand may be expected within the next few weeks on these plots. This is further supported by the number of growing points counted in these same samples (Table 5).

Blocks 3 and 4, which were treated 10 days later than blocks 1 and 2, had a generally greater new rhizome growth and a greater number of growing points, possibly the result of greater bud growth before contact, stimulated by the plowing and preliminary field cultivation. Another factor may have been the fact that the later applications were made in the middle of a 12-day period of no precipitation, whereas the first two blocks were treated during an 8-day period during which there was a total precipitation of half an inch on five days of showers and high humidity.

There was no correlation between treatments and susceptibility of growing points to grub and nematode injury, although the undisturbed sod showed strikingly little injury. Also growing points in heavily compacted soil were undamaged, though extremely stunted.

The minimum depth of origin of new crowns was increased in every case by IPC applications. New crowns on all check plots were found to originate at all depths in the soil, clear up to the surface. No IPC plot showed new crowns originating at a lesser depth than one inch, indicating possibly that the buds were kept in a dormant state for a long enough period of time for the complementary action of IPC and desiccation in this surface layer to effect a kill. This minimum depth of origin was considerably greater where thorough incorporation was employed and showed some correlation to rate of application of IPC.

The complete inactivation of the IPC in the soil by September 22 was indicated by the sprouting of numerous lateral buds on new rhizomes at all depths in the soil on treated and untreated plots alike.

The marked increase in number of growing points and new rhizomes at the 5-pound and 10-pound levels of application after deep plowing (treatments 18 and 20, Block 4) point to a possible stimulation of bud growth at very low effective concentrations, an effect reported on wheat seedlings by Taylor (4).

SUMMARY

The data presented do not lend themselves to statistical analysis. The work undertaken was of an exploratory nature to determine, with a limited supply of material, the response of quack grass in an established sod to field applications of isopropyl-phenylcarbamate, using equipment available to many farmers.

The results seem to indicate that IPC has little effect on the growing points of new rhizomes. At present, it appears that field applications will be most effective immediately after removal of top growth for hay at a stage approaching early maturity, at which time few growing points are to be found in the soil and the great majority of lateral buds on the rhizomes and buds at basal nodes of crowns are dormant.

The material is soluble enough to make surface applications of 30 pounds per acre on an undisturbed sod effective in delaying bud development for 30 to 60 days. However, such treatments do not kill rhizomes, and the inhibition is apparently not permanent.

Mechanical incorporation with the soil must be expeditious and thorough. New bud growth is stimulated by removal of the tops as hay and by disruption of the sod by tillage. Contact must be made by the material with the dormant buds before the meristematic tissues become covered with an actively growing sheath.

Thorough mixing can be achieved with a field cultivator or similar conventional surface tillâge implement only by covering the area as many times or more as would be required to execute an effective summer fallow with properly spaced cultivations.

The efficiency of the isopropyl-phenylcarbamate with mechanical mixing may be increased by compaction following incorporation with the soil. Theoretically, a number of factors may enter into this increased effectiveness: 1. More continuous water films for chemical diffusion and capillary migration of the material. 2. More intimate and continuous contact between soil solution and rhizomes. 3. Decreased aeration, resulting in reduced bacterial inactivation and extended presentation period for the material. 4. Physical impedance to shoot emergence.

The effects of the isopropyl-phenylcarbamate and desiccation and mechanical injury resulting from summer fallow tillage seem to be complementary in actually killing rhizomes. It is not established whether previous desiccation, mechanical injury and disturbance

in the soil make the rhizomes more susceptible to permanent injury by the chemical, or vice versa.

Either spray or dust appear to be satisfactory forms for application. In either case, the material should be finely divided for uniform coverage. Spray applications must utilize agitation to maintain uniform suspension, since IPC is not sufficiently soluble for practical application in solution. Use of the herbicide as a dust would permit the economy of applying it with fertilizer in a single operation.

Isopropyl-phenylcarbamate seems to be inactivated in the soil in 30 to 60 days, depending on the rate of application and the degree of aeration in the soil.

It is not clear that the herbicide used alone actually kills the buds, even when contact is made. The rhizomes, themselves, remain alive for a considerable period, unless exposed to desiccation.

Obviously much more work must be done with this chemical growth regulator before its release to the practical farmer as a quack grass killer.

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DAIRY COSTS AND RETURNS IN DETROIT MILK SHED IN 1946

*By E. H. Carter**
SECTION OF FARM MANAGEMENT

How MUCH is it costing Michigan dairy farmers to produce milk? To provide the answer to this question, a cooperative dairy cost study is being conducted by the Michigan Milk Producers Association and the Farm Management Section. Detailed records on cows, bulls, and youngstock are being kept by approximately 100 cooperating members of the Michigan Milk Producers Association located in 12 counties of the Detroit Milk Shed area. In order to have current cost figures, an average of operating costs (feed, labor, and miscellaneous cash expenses) and returns from cows has been compiled monthly since April of 1945. At the end of each year an annual summary has been prepared showing both operating and overhead costs and the returns per cow, each 100 pounds of milk, and per pound of butterfat, in addition to the costs and credits per bull and each head of youngstock. The 1946 annual summary included 95 records.

On these 95 farms the average-sized herd was 16.2 cows (Table 1). Size of herd ranged from 6 cows to 37. The milk production per cow averaged 8,186 pounds and ranged from 5,296 to 11,424 pounds per cow per year. The average butterfat production per cow was 303 and ranged from 212 to 408. As to breed of herds there were 53 Holstein, 11 Guernsey, 5 Jersey, and 26 other or mixed breeds. For the year, the milk tested 3.71 percent butterfat as an average of all herds. However, average butterfat test for the year varied from 3.11 percent to 5.43 among the 95 herds.

COSTS PER COW

Total costs per cow for the year amounted to $340 (Table 1). Total feed costs amounted to $161 or nearly half of all costs. The value of the feed was entered by the cooperators at farm price if produced

*Suggestions for this summary were given by E. B. Hill, K. T. Wright, and the Cost Study Committee of the Michigan Milk Producers Association. Sales committeemen were also very helpful in the study.

ARTICLE 30-31

TABLE 1—*Cow costs and income on 95 herds in 1946*

Item	Average
Average number of cows per farm	16.2
Milk production per cow in year	8,186
Butterfat production per cow	303
Butterfat test of milk (%)	3.71
Labor charge per hour (all labor)	$ 0.83
FEED FED PER COW IN YEAR	
Concentrates (lb.)	2,840
Hay (lb.)	4,343
Silage (lb.)	5,078
Other roughage (lb.)	503
Pasture (days)	149
COSTS PER COW IN YEAR	
Feed	$ 161.45
Labor	110.20
Cow depreciation	4.27
Interest on cows	8.78
Building use	9.58
Equipment use	6.16
Bull cost or fees	9.72
Bedding	7.07
Electricity	2.97
Veterinary and medicine	2.09
Miscellaneous cash expenses	1.80
Overhead*	16.12
Total	$ 340.21
INCOME PER COW IN YEAR	
Milk sold and used	333.63
Subsidy	10.16
Calves at 5 days	7.47
Manure	8.45
Total	$ 359.71
Net return	19.50
Return per hour (all labor)	.98
Return per hour for operator's labor	1.14
Charge made by operator for his labor	.94
Hired labor charge per hour	.56
Family labor charge per hour	.63

*This is an estimated share of such general expenses as auto, telephone, etc., that could not be charged directly to dairy.

on the farm or at actual cost if purchased. The average cow in the study consumed 2,840 pounds of concentrates, a little more than 2 tons of hay, 2.5 tons of silage, and 0.25 ton of miscellaneous roughage such as corn fodder and corn stover. There was also an average of 149 days of pasture each cow a year. As an average for the year, concentrates were valued at $2.92 per 100 pounds, hay was valued at $19 per ton, and silage at $7.92 a ton. Miscellaneous roughage averaged $7.28 per ton and pasture averaged 12 cents each cow a day.

Labor amounted to nearly a third of total costs. These dairymen averaged 132 hours each cow a year. Labor requirement per cow varied from 79 hours to 437. Hired labor rates were determined by the hired man's wages plus room, board or any other items furnished him by the farmer. This charge amounted to 56 cents an hour. The

farmer entered what he considered a fair charge for both his own time and the time spent by his family in the dairy business. These rates were 94 cents and 63 cents an hour, respectively. The charge for all labor averaged 83 cents an hour for all herds.

All other costs amounted to $69 a cow or about one-sixth of total costs. These costs included such items as cow depreciation, interest on cows, building and equipment use, breeding costs, bedding, electricity, veterinary and medicine, and other miscellaneous items. Some few of the dairy herds had cow appreciation, but depreciation on other herds was great enough so that the group of herds as a whole had cow depreciation cost. The item "bull cost or fees" represents an average of bull costs, artificial breeding costs, and bull fees paid.

Total income per cow amounted to about $360. Milk sold and used on the farm (fed to calves and used in house) amounted to $334, and subsidy amounted to $10 per cow. Cow credits—calves and manure—were valued at $16 per cow. The net return per cow above all costs was $19.50. The return per hour of labor was 98 cents.

COSTS PER 100 POUNDS MILK

Figured on a per 100 pound basis, it cost these 95 dairymen $4.16 to produce milk (Table 2). Feed cost per 100 pounds was $1.97, labor cost amounted to $1.35 and all other costs were 84 cents a 100 pounds

TABLE 2—*Milk production cost and income per cwt. in 1946*

Item	Average
Milk production per cow (lb.)	8,186
Hours labor per cwt. milk	1.62
FEED FED PER CWT. MILK	
Concentrates (lb.)	34.7
Hay (lb.)	53.1
Silage (lb.)	62.0
Other roughage (lb.)	6.1
Pasture (days)	1.8
COSTS PER CWT. MILK	
Feed	$ 1.97
Labor	1.35
All other items*	.84
Total	$ 4.16
INCOME PER CWT. MILK	
Milk sold and used	4.08
Other	.31
Total	$ 4.39
Net return per cwt. milk	.23

*Includes all costs other than feed and labor as shown in Table 1.

of milk. As to income, milk sold and used amounted to $4.08 and other income amounted to 31 cents, for a total income of $4.39 per 100 pounds of milk. Hauling costs and association dues were deducted from the price received for milk sold. The net return or profit above all costs for producing 100 pounds of milk was 23 cents.

The cost of producing milk varied considerably among these dairymen. This ranged from $2.84 to $9.68 per 100 pounds of milk. Differences in the amount of production per cow, the size of herd, and the degree of labor efficiency help to explain the variation in milk production costs.

COSTS PER POUND OF BUTTERFAT

Inasmuch as butterfat test varied from 3.11 percent to 5.43 and butterfat production per cow varied from 212 to 408, costs and returns are shown on a per pound of butterfat basis (Table 3). Of a total cost of $1.12 a pound of butterfat, 53 cents was for feed, 36 cents was for labor, and 23 cents was for all other items. Of a total return of $1.18 a pound for butterfat, $1.10 was for milk sold and used and 8 cents was for all other items—subsidy, calves and manure. The net return per pound of butterfat above all costs amounted to 6 cents.

The average butterfat test for these herds was 3.71 percent. Butterfat production per cow per herd averaged 303 pounds for the year.

TABLE 3—*Butterfat production cost and income per pound, 1946*

Item	Average
Butterfat production per cow (lb.)	303
Butterfat test of milk (%)	3.71
COSTS PER POUND OF BUTTERFAT	
Feed	$ 0.53
Labor	.36
All other items	.23
Total	$ *1.12
INCOME PER POUND OF BUTTERFAT	
Milk sold and used	1.10
Other	.08
Total	$ 1.18
Net return per pound of butterfat	.06

*For dairymen producing cream, skimmilk credit would reduce the cost per pound of fat.

TABLE 4—*Bull costs and credits on 77 bulls, 1946*

Item	Average
Hours labor per bull in year	86
FEED FED PER BULL IN YEAR	
Concentrates (lb.)	1,468
Hay (lb.)	5,772
Silage (lb.)	2,879
Other roughage (lb.)	131
COSTS PER BULL IN YEAR	
Feed	$ 112.19
Labor	74.47
Bull depreciation	0.00
Interest on bull	10.09
Building use	12.97
Bedding	11.67
Other	1.37
Overhead	11.43
Total	$ 234.19
CREDITS PER BULL IN YEAR	
Manure	8.74
Fees received	1.10
Bull appreciation	10.24
Total	$ 20.08
Net cost of bull for year	214.11
Number of cows and heifers of breeding age	19.3
Net bull cost per cow and heifer	$ 11.09

COSTS PER BULL

Seventy-seven bulls were used on these farms. The hours of labor, feed requirements, itemized costs and credits per bull for 1946 are shown in Table 4. A total of 86 hours was required in the care of a bull. About 1,500 pounds of concentrates, nearly 3 tons of hay, and 1.5 tons of silage were required for feed.

Total costs per bull amounted to $234. Feed costs were $112 or about half of all costs. Labor amounted to $74 or about a third of all costs. Bull credits consisting of manure value, fees received, and bull appreciation, amounted to $20. Therefore, the net cost per bull a year was $214. On the farms keeping bulls, there was an average of 14.8 cows and 4.5 heifers bred. The net bull cost per service was $11.09, but this varied on individual farms from 50 cents to $30.46.

COSTS OF RAISING YOUNGSTOCK

The 95 cost cooperators kept an average of 16.2 cows for the year and had an average of 5.9 calves under a year and 6.8 heifers over a year, or a total of 12.7 head of youngstock per farm. The costs of raising youngstock (heifer and calf costs combined) for 1946 are shown in Table 5.

TABLE 5—*Youngstock cost and income in 1946*

Item	Average
Calves under one year on farm	5.9
Heifers over one year on farm	6.8
Total number of youngstock	12.7
Average number of cows	16.2
Average number of heifers freshened	4.2
Price placed on heifers at freshening	$ 179
Hours labor per head youngstock in year	20
COSTS PER HEAD OF YOUNGSTOCK IN YEAR	
Feed	$ 54.86
Labor	16.58
Calf value at 5 days	9.52
Interest on youngstock	4.39
Building use	5.27
Bull cost or fees	3.48
Bedding	3.38
Other	.61
Overhead	4.90
Total	$ 102.99
INCOME PER HEAD OF YOUNGSTOCK IN YEAR	
Net increase	74.69
Manure	4.38
Total	$ 79.07
Net return per head of youngstock	−23.92
Return per hour all labor	− 37

According to the reports of these dairymen, to raise a calf to 2 years of age would apparently require about 670 pounds of milk, 1,000 pounds of concentrates, 3,400 pounds of hay, 2,300 pounds of silage, and 180 pounds of miscellaneous roughage in addition to pasture during the summer months.

Feed costs per head amounted to $55, a little more than half of total costs. Twenty hours of labor per head were required in the care of youngstock. This was charged in at about $17. Calves at 5 days of age were charged into the youngstock account from the cow account. This averaged about $9 per calf. Total costs for one year amounted to $103. At this total cost per year, it was costing these dairymen about $206 to raise a two-year-old heifer to freshening. The average price placed on heifers at freshening by the cooperators was $179.

As to income, net increase in youngstock value amounted to $75. Net increase was determined by crediting the value of youngstock sold or butchered, the value of the heifers at freshening when transferred to the cow account, and the value of the ending inventory to the youngstock account. Beginning inventory and purchases were sub-

tracted from total credits. In addition to this $75 net increase, manure credit amounted to $4, making a total youngstock income of $79.

On a per head of youngstock basis, the net income lacked $24 of paying the costs of raising youngstock. On a per hour basis, the returns from youngstock lacked 37 cents of paying any return on labor.

REPORT ON CHEMICAL WEED CONTROL FOR CONIFER SEEDLINGS AND TRANSPLANTS

By P. W. ROBBINS, B. H. GRIGSBY, and B. R. CHURCHILL
SECTIONS OF FORESTRY, BOTANY AND FARM CROPS

THE USE of chemicals for weed control in the forest nursery is not new. Kitchin (1), in 1920, found that sulfuric acid and zinc sulfate reduced weed development without injuring conifer seedlings. Steven (3), in 1928, discovered that a one-percent solution of copper sulfate decreased weed growth. Toumey and Li (4), in 1928, also found that sulfuric acid reduced the germination of weed seeds in seedbeds. Wahlenberg (5), in 1930, conducted intensive tests with zinc sulfate for the control of weeds in forest nursery seedbeds, but the experimental results did not prove practical enough, in field application, to be widely accepted by the large nurseries. In any event, Olsen (2), in the same year, while recommending that chemicals could be used for weed control, cautioned that they should be used with care in the seedbed; he did recommend chemical control, however, for cleaning up areas overgrown with weeds.

In the spring of 1946 a series of weed control plots in one-year-old seedbeds of Norway and White spruce, Jack pine, Douglas fir and Balsam fir, and in transplant rows of Northern White cedar, White spruce and Red pine were established. A 2-percent solution of sulfuric acid, 5-percent solution of phosforic acid, Dow Selective Weed Killer, 2,4-D, and Stanisol* were used. The trials indicated Stanisol to be the only chemical that would control the weeds and not harm the conifer trees.

Stanisol was tested more intensively during the summer on conifer seedlings which had made one month to 6 weeks' growth. The areas sprayed during 1946 included 2,000 square feet of White and 600 square feet of Ponderosa pine, and 400 square feet of Norway spruce. The spray was applied on warm bright days, using a back-pack sprayer and a fog nozzle. The naphtha was applied full strength and only at

*Stanisol is a petroleum product of the naphtha series, containing approximately 10 percent of aromatic compounds, distributed by the Standard Oil Company of Indiana.

ARTICLE 30-32

a rate heavy enough to wet the weed leaf surfaces. One-half hour after the application, the weed leaves curled up and no trace of the Stanisol could be seen, as that which had not penetrated the leaves had evaporated. The weeds killed included curly dock, lamb's-quarters, common chickweed, purslane, dandelion, crab-grass and pigweed. Common ragweed, quack grass and June grass were damaged but not killed. Even though all weeds were not killed the results in the seedbeds were considered very favorable, particularly as there was no damage to the seedlings. Weeding was reduced but not eliminated.

On June 26, 1947, a warm day, 6,400 square feet of 10-day-old White pine seedlings were sprayed with Stanisol, using 4 gallons to 2,400 square feet. The same day 2,000 square feet of one-year-old White pine, which had been sprayed in 1946, were also sprayed at the same rate.

Three days after treatment 84 percent of the weeds in the 10-day-old seedlings and 56 percent of the weeds in the one-year-old beds were dead. The weeds in the one-year-old beds were killed wherever the density of the pine seedlings did not protect the leaf surface of the weeds. Three days after spraying, one of the White pine beds was weeded of all living weeds in one hour. An equal area of unsprayed White pine beds required 5½ hours to remove all the weeds. Both

Fig. 1. Sprayed and unsprayed Ponderosa pine seedlings.

beds were weeded by the same man. Examination 3 days after spraying revealed no noticeable damage to the pine seedlings. Twenty-four days after germination, and 14 days after spraying, the White pine showed damage of 15.3 percent on one counting plot and 15.5 percent on a second plot. The year-old pines showed no damage.

On June 30, 6,000 square feet of White pine and an equal area of Ponderosa pine were sprayed with Stanisol, immediately after the mulch was removed and before the seed coats had been shed from the cotyledons. The Ponderosa pines showed no damage and only 1.2 percent of the White pine seedlings were damaged.

Figure 1 illustrates beds of sprayed Ponderosa pine on the left and unsprayed on the right. Only a few weeds, adjacent to the seedbed boards, which were protected somewhat from the spray, remain in the sprayed bed. The unsprayed bed is so covered with weeds it is difficult to see the young trees. The spray was applied June 30 and the photograph taken July 14.

On July 17 these beds were weeded. The sprayed bed required one hour and ten minutes to remove the remaining weeds, while the unsprayed seedbed required 11½ hours to remove all the weeds.

On July 7, 24 rows of 2-year-old Red pine seedlings, which had been machine-transplanted on June 12, 13 and 14, and cultivated twice up to July 7, were sprayed with Stanisol. The weeds, predominately lamb's-quarters and crab-grass, were small and the spray killed them so effectively that no row weeding has been necessary. Examination of the trees on July 22 revealed no damage.

CONCLUSIONS

The use of Stanisol will effectively reduce the weeding problem of the nurseryman in pine seedling beds, and will cause little damage if applied while the seed coats are still on the cotyledons, or if applied after the trees have reached one year of age.

Stanisol is effective for the control of weeds in transplant rows if the spray is applied while the weeds are small.

Enough Stanisol should be applied to wet the leaves of all weed plants. One gallon per 600 square feet is a suggested rate of application but more may be required when weed growth is heavy.

Some differences in the tolerance of various species of conifers have been found, and small scale trials on species other than Pon-

derosa and White pine, are suggested before treating large areas of young seedlings.

Low spraying pressures, 50-75 pounds, are adequate for weed control. Pressures in excess of 100 pounds may cause injury to the seedlings and should not be used.

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THE USE OF DINITRO PHENOL FOR THE CONTROL OF ASPEN

By MAURICE W. DAY

DUNBAR FOREST EXPERIMENT STATION

ASPEN HAS steadily increased in value during recent years, but it still remains a problem species on millions of acres of lighter soils in the Lake States. Shirley (4) has ably presented the problem of restoring conifers to these lands. Much release work will be involved and it will call for low-cost methods. This article is concerned with a new method of killing aspen.

The three principal methods of controlling an undesirable aspen overstory are cutting, girdling, and poisoning. Each has its disadvantages: cutting results in a dense sprout growth; girdling is not adapted to sapling sized stands; and poisoning may be a hazard to wildlife and to man.

The standard method of poisoning aspen has been that described by Pessin (2), using sodium arsenite. The author has found this very effective on aspen, but it involves the use of a very deadly poison and is difficult to apply in sapling stands.

The method described here uses a different type of poison which is much less toxic and, with ordinary care, can be used with safety; Crafts (1). An oil solution containing dinitro ortho secondary butyl phenol is sprayed on the trunk of sapling sized aspen. Within 10 to 30 days the cambium layer becomes discolored, the leaves wither, and the tree dies.

During the field seasons of 1945 and 1946, several solutions containing this toxicant were tested. These solutions were supplied through the courtesy of the Dow Chemical Company of Midland, Michigan. The solution, supplied by the manufacturer under the Code Number of G414, gave consistent results. The spray solution was prepared by adding 5 percent by volume of the G414 to a given volume of kerosene, which gave a concentration of 0.05 pound of the toxicant per gallon of spray solution. The spray was applied with an

ARTICLE 30-33

ordinary knapsack sprayer. The trees were sprayed from the ground line up to about 4½ feet on all sides of the stem. The treatment can be applied more quickly than by using sodium arsenite and can be very selective, for an aspen growing close to a conifer can be sprayed without injuring the desirable tree. Care must be taken to avoid spraying desirable vegetation since all leaves or needles struck by the spray will be killed.

The treatment was very effective on the smaller trees but did not produce as good results on larger trees. Trees in the 0 to 3-inch DBH classes were completely killed in practically all cases. Above 3 inches DBH, there were more cases of incomplete kills, and in the 5- and 6-inch classes many trees appeared to be uninjured. It must be concluded, therefore, that this method is not applicable at present above about 3 inches DBH.

These experiments were carried on during the season of active growth from June to early August; the results, therefore, are applicable to this period only. Recently several herbicides have been placed on the market which contain this toxicant in varying concentrations and with different carriers. It was impossible to give these solutions a test on aspen, and they may not give comparable results.

The trees killed by this method in 1945 gave no evidence of sprouting either in 1945 or 1946. This may seem surprising in view of aspen's ability to sprout and sucker from the roots. However, it has been noted (2) that there may be dead stems between healthy suckers on the same root system. The death of these stems by this method may simulate natural death and not tend to produce suckering as cutting would do. Similar results were noted with sodium arsenite. More experimental work is needed on this phase of the problem, but preliminary results indicate that suckering will not occur when only a portion of the trees in the stand are treated.

From the results of this work it appears that certain solutions of dinitro ortho secondary butyl phenol applied to the stems of aspen saplings may prove to be an effective and efficient method of eliminating undesirable stems from the stand.

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REPRODUCTION IN A STOCK COLONY OF ALBINO RATS, 1937-46, INCLUSIVE

By ANNANELL C. JUBB, DENA C. CEDERQUIST, and MARGARET A. OHLSON

SECTION OF FOODS AND NUTRITION

ALTHOUGH MANY laboratories keep records of the growth and reproduction of stock colonies of albino rats, few data have been published (5, 10, 11). It is common knowledge that many colonies of inbred rats suffer occasional reproductive failure, but a diligent search of the literature failed to disclose a single record of such failure. It is well known, also, that a large number of rats suffer chronic lung lesions. This also is rarely mentioned as a possible influence in experimental work.

Periodic failure in reproduction occurred in the colony of albino rats maintained by this department during the years 1937-46, inclusive. This paper records the known facts contributing to this failure and discusses the question of cost of breeding experimental rats under routine laboratory conditions.

The stock colony of the Foods and Nutrition Department, Michigan State College, was established in 1924 with albino rats of the Wistar strain. They were housed in wire-mesh cages on wood shavings, with about six animals in a cage. The room was on the second floor of a permanent building and was equipped with a separate steam line from the power plant which guaranteed a minimum temperature of 80° F. at all times. There was no control of higher temperatures during the summer months or of humidity at any time.

Female rats were weighed at weekly and males at monthly intervals. When they were 4 months old, the animals were mated, and were discarded when four litters had been reared unless the need for animals was urgent. Litters of more than eight were reduced to that number, except from 1944 to 1946 when so few animals were born that the mothers were allowed to rear all of them. Second litters were saved for stock.

ARTICLE 30-34

TABLE 1—*Percent composition of stock colony rations*

Ingredient	Prior to 1941 (percent)	Dietary changes by years			
		1941 (percent)	1942 (percent)	1943-1944	Late 1944-1947* (percent)
Powdered milk	32.7 (whole)	14.4 (whole)	24.0 (skimmed)	Commercially prepared dog biscuit.	5.0 (skimmed)
Na Cl	0.4		1.3		0.5 (iodized)
Ca Co_3		0.96			0.5
Cod liver oil	2.0		0.32		
Yellow corn	49.0	23.0			52.0
Whole wheat flour		24.0	65.7		
Wheat germ					10.0
Linseed oil meal	10.3	9.6			16.0
Rolled oats		24.0			
Alfalfa	1.4				2.0
Casein	3.5				5.0
Kelco meal		3.8			
Bone ash	0.7				
Yeast					5.0
Corn oil			8.5		

*Supplemented with reconstituted milk, iodine, manganese, copper, aluminum, and cod liver oil.

The ration of the colony was changed several times as wartime shortages made it necessary. These changes are indicated in Table 1. Raw liver or beef and greens were given twice a week, when available, during the entire period. As can be seen from tables 2 and 3, reproduction on these diets varied widely. In 1942 female rats of the Sprague-Dawley strain were imported in the hope that the reproduction difficulty was due to inbreeding. A slight improvement was noted,

TABLE 2—*Yearly total of number of litters born and reared, and percent of fertile matings*

Year	Litters	Number of young					Fertile* matings
		Born		Reared			
	total	total	av./litter	total	av./litter	percent	percent
1937	326	2615	8.0	2006	6.1	76.7	
1938	470	3993	8.5	2360	5.0	59.1	
1939	443	3985	8.9	2707	6.1	67.9	
1940	539	4277	7.9	2990	5.5	69.9	
1941	574	4372	7.6	2662	4.6	60.8	
1942	81	716	8.8	467	5.7	65.3	83.1
1943	195	1377	7.0	901	4.6	65.4	67.6
1944	51	327	6.4	239	4.6	73.0	29.3
1945	87	594	6.8	458	5.2	77.1	56.2
1946	49	284	5.8	213	4.3	75.0	30.1
Total	2815	22470		15003			
Mean			7.9		5.3	66.7	

*"Fertile matings" indicates those producing litters.

but the effects were not long lasting. Reproduction fell to a low level and remained much the same regardless of dietary changes.

The mean numbers of young born and reared in this colony are slightly less than those of other stock colonies. Greenwood (1) found a mean of 6.9 young in reduced litters with 5.1 (73.6 percent) reared. Smith (10) reported 7.3 young in reduced litters, of which 5.8 (79.6 percent) were reared. The means for a 10-year period in this colony were 7.9 young born and 5.3 (66.7 percent) reared.

The primary reason for a stock colony of rats is to produce animals of maximum uniformity for experimental purposes. However, if a stock colony is to be worth the time, labor and money that go into its maintenance, it must produce animals at reasonable cost, since commercial sources now provide animals reared under well controlled conditions. The annual cost of operating this colony exclusive of the overhead such as rent, heat and light has been estimated for the period 1937-46. The lowest cost per rat reared has been \$0.55, the highest, \$9.52. The mean cost per rat for the 10 years considered was estimated as \$1.16. From 1942 through 1946, the stock colony failed to produce sufficient animals to meet the needs of the department for teaching and research and it was necessary to purchase animals. The availability of healthy animals of correct age, sex and weight, at the time needed has out-weighed any advantage gained by litter mate controls. Commercial sources have provided vigorous animals, free from disease at a cost ranging from \$0.75 to \$1.50 per animal depending on size, age and degree of "matching" required by any specific order. In these laboratories, no studies involving inheritance are in progress.

TABLE 3—*Yearly distribution of litters and of young born in litters*

Year	Distribution											
	Of litters						Of young in litters					
	1	2	3	4	5	6	1	2	3	4	5	6
1937	126	108	68	21	3	0	1051	839	536	160	29	0
1938	127	121	93	72	52	5	1063	1093	823	607	363	44
1939	141	123	107	56	14	2	1172	1119	1086	469	119	20
1940	180	134	108	99	9	0	1388	1093	887	831	78	0
1941	139	179	139	91	26	0	1065	1379	1081	653	194	0
1942	48	27	6	0	0	0	385	261	56	0	0	0
1943	65	52	52	21	5	0	488	353	369	136	30	0
1944	26	16	6	1	2	0	138	114	39	4	10	0
1945	41	26	12	6	2	0	320	168	75	27	9	0
1946	13	17	12	7	0	0	95	90	80	24	0	0

TABLE 4—*Incidence of infection in the stock colony and its relation to fertility in the females*

Lesions	Total	Percent	Number of rats		Matings	
			Male	Female	Total	Fertile* Percent
None	15	16.3	3	12	55	47.2
Lungs only	53	57.3	14	39	200	45.0
Genital organs only	6	6.5	....	6	28	53.5
Lungs and genital organs	11	11.9	....	11	43	46.5
Lungs and kidneys	4	4.3	....	4	17	35.3
Lungs and urogenital tract	3	3.2	....	3	19	26.3
Total	92	....	17	75	344	47.6

*"Fertile matings" indicates those producing litters.

Routine gross autopsy of animals that had died or had been sacrificed was begun in late 1944. These autopsies revealed extensive lung lesions in the colony, and are summarized in Table 4. Macroscopically the lungs were as many as five times as large as normal, were consolidated, gelatinized, and sometimes calcified. There were nodular distentions of caseous material in the centers of which pus was found. More lesions were observed in females and secondary nodules were seen only in females. The possibility of tumor growths with metastases was investigated by the Department of Animal Pathology,[1] who reported that the condition resembled a severe infection. Earlier work by the Department of Bacteriology[1] led them to conclude that a virus was responsible since specific organisms could not be isolated. That the infection was chronic is substantiated by the fact that very few of the animals died of natural causes even though some of the lung tissues seen were almost completely replaced by caseous nodules.

Microscopic examination of lung tissue sections revealed dense aggregations of leucocytes outside the bronchii and bronchioles which seemed to follow their course like a sheath. Occasionally the bronchioles and alveoli were filled with mucous and leucocytes.

Such lung involvement is widespread in albino rats. Attempts have been made to identify the responsible organisms, dietary or environmental fault. Klieneberger (2, 3) has isolated organisms she believes are responsible, but Nelson (6, 7) insists that there are several organisms involved in a symbiotic relationship.

[1]The authors' thanks to Dr. R. F. Langham and Dr. Frank Thorpe, Jr., of the Department of Animal Pathology, and to Dr. H. J. Stafseth of the Department of Bacteriology and Public Health.

Slonaker (9) in his studies of the protein requirement of rats reported that the most frequent cause of death was "lung trouble," and that this was not related to protein intake. Passey and his co-workers (8) were able to correlate keratinization of the metaplastic epithelium of the bronchiectatic cavities with avitaminosis A, and warned of misinterpretation of all stages of the disease process.

McCay (4) found that "lung trouble" was the single most important cause of death of rats in his longevity experiments, and attempted to determine the environmental factor responsible by a series of side experiments. These included temperature and humidity control, wet and dry diets, separate and group housing. He was not able to demonstrate that any of these factors influenced the occurrence of the process. In this colony the rats were fed a dusty diet, housed several to a cage, on wood shavings in a room with limited temperature and no humidity controls. However, if the cost of air conditioning, individual cages and more elaborate dietary mixtures were added to the cost itemized earlier in this paper, the total expense of a small colony would certainly not be justified.

Table 4 records the incidence of lung lesions in female animals in relation to breeding performance. It will be noted that those females with lung lesions, with lesions of the reproductive tract, or both were about as fertile as those who appeared normal. When the kidneys were affected, fertility declined rapidly, but there were very few rats so affected. Undoubtedly reproductive function would be depressed in the presence of chronic infections of this nature. Since organs appearing normal were not examined microscopically it is not known that all of the animals exhibiting no gross lesions were completely normal. It is difficult to assess the various factors involved in the reproductive failure of this colony. However, if the difficulty were due to inbreeding, the importation of females of more vigorous stock should have given more lasting improvement in reproductive performance. Similarly, if the fault were dietary, the improvement of the diet from 1944 through 1946 should have been reflected in an upward, rather than a downward trend in reproductive performance. The increased intensity of lung lesions observed in this colony of albino rats apparently has been seen elsewhere.[1] Even though the reproductive failure observed is not related to the lung condition, such affected animals can hardly be considered satisfactory for use in dietary studies.

[1]Personal communication from Dr. P. R. Cannon.

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VOLUME 30 FEBRUARY 1948 NUMBER 3

CONTENTS

(Continued on Next Page)

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: (1) progress reports on long-term major research projects; (2) final reports on short-term projects and (3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

CONTENTS

(Continued from Outside Front Cover)

SOME PRACTICAL ASPECTS OF MILK HYGIENE

By C. S. BRYAN
SECTION OF SURGERY AND MEDICINE

MANY PROFESSIONS are vitally interested in and concerned with the sanitary production, processing and distribution of a safe milk for the consuming public. All members of those professions must have a wide perspective of the ultimate goal in order that each may best integrate his efforts with the others for insuring the best milk for all. To accomplish this end, the members of those professions must be ready to advise dairymen accurately concerning all phases of dairy hygiene. Above all, if the farmer is to apply successfully the sanitary procedures recommended to him they must be economically sound. Some practical aspects of milk hygiene are herein presented.

A CITY MILK SUPPLY

The overall picture of a city milk supply is complex, but an understanding of its various aspects is essential if one is to comprehend the far-reaching effects of any advice in milk hygiene given a dairyman. The milk picture for the city of Lansing, Michigan, with a population of almost 100,000 will illustrate a typical setup:

10 000 cows producing the milk on
1,000 farms with
45 haulers conveying the milk to the
10 city milk plants where it is processed, and delivered to the consumer by
120 wagons and trucks (100 retail, 20 wholesale)

THE ESSENTIALS OF CLEAN AND SAFE MILK PRODUCTION

The health of the cows and the methods of caring for the cows, the utensils, and the milk on the farm determine the type of milk that is produced. The need for adequate barn and milkhouse facilities and

ARTICLE 30-35

TABLE 1—*The bacteria count of milk produced by healthy and diseased cows. Samples collected aseptically from the cows*

Udder infection	Bacteria per cc. of milk	
	Percent with fewer than 1,000	Percent with more than 1,000
None	95	5
Brucella	76	24
Streptococcus	30	70
Staphylococcus	25	75
Coliform	15	85

dairy equipment is recognized, so no data are presented on these subjects. An appreciation of the influence of each essential item upon the quality of the milk will stimulate the correction of conditions, where needed, to make possible the production of good and safe milk.

1. **Clean and Healthy Cows**—The health of the dairy cow is the keystone of a safe milk supply of high quality. The fitness of cattle to produce such milk is determined by their freedom from disease. Under no circumstance should the milk be used if the cattle are obviously suffering from any disease. The data in Table 1 reveal the influence of udder infection on the quality of milk produced, for in each case of udder infection the percentage of cattle producing milk with a bacteria count of over 1,000 increases greatly.

The influence of cleanliness of the cow on the bacteriological quality of the milk produced is presented in Table 2. These results indicate the value either (a) of clipping the long hair on the udder and rear quarters several times a year, by reducing the number of bacteria per cc. from 20,000 to 5,000, or (b) of disinfecting the udder and teats

TABLE 2—*The bacteriological condition of the milk produced by hand milking of apparently clean, healthy cows under varying management conditions (A chlorine solution of 300 parts per million of available chlorine used for disinfection)*

Management condition		Bacteria per cc. of milk
Hair on udder and rear quarters	Disinfection of udder and teats	
Not clipped	None	20,000
Not clipped	Yes	6,800
Clipped	None	5,000
Clipped	Yes	550

prior to each milking in maintaining the high quality of milk, indicated by the bacteria count of 6,800, as it is obtained from the healthy cow. Best results were obtained when both clipping and disinfecting were done, for here the bacteria count of milk produced was only 550. The necessity for having clean premises—such as lots, lanes, etc.—and the value of barns that are clean and well bedded, are obvious in quality milk production.

2. **Clean and Healthy Handlers**—The clothes of the handlers should be clean, especially during the milking process, so as to preclude the possibility of them ever becoming a source of contamination. Since the hands have a more intimate contact with milk a study of their influence is indicated. An opportunity presented itself to study the bacteria count of milk produced by hand milking under various conditions; the results are presented in Table 3. In all cases only clean and sanitized utensils were used to handle the milk, thus reducing to a minimum the bacterial contamination from this source.

The bacteria count of milk collected aseptically was normal for healthy cows, being 300 and 400 respectively for the two groups of cows. The dry brushing of udders prior to milking was not enough to prevent dandruff and some other debris with bacteria from falling into the milk as revealed by the 16,000 count of milk from the apparently clean cows and 350,000 from the obviously dirty cows. Wiping with water alone removed some of the gross dirt, but the bacteria count of milk obtained was higher, 56,000 for the clean and 425,000 for the dirty cows, than when only dry brushing preceded the hand-milking process. Disinfection of the udders and teats, although not perfect, resulted in the production of milk with a very low bacteria count; 700 by the clean and 1,500 for the dirty cows. The value of

TABLE 3—*The bacteria count of milk produced by the hand milking of healthy cows (whose udders had been clipped) that were either reasonably clean or reasonably dirty when the udders and teats were either dry, wiped with water only, or disinfected (solution of 300 p.p.m. available chlorine or 1 to 1,000 quaternary ammonium solution)*

Appearance of rear quarters and udders of cows	Bacteria per cc. of milk produced			
	Collected aseptically from cow	After dry brushing	After wiping with water	After disinfection
Reasonably clean	300	16,000	56,000	700
Reasonably dirty	400	350,000	425,000	1,500

TABLE 4—*Number of bacteria on dairy utensils*

Farm	Equipment rinsed with 500 cc. of sterile water	Bacteria on equipment	
		Utensils ready for use as found on the farm	Utensils sanitized with chlorine
1	1 pail and 1 strainer	28,000,000	1,500
2	1 pail and 1 strainer	700,000	500
3	1 pail and 1 strainer	2,000	1,000

clipping and disinfection is obvious from these results. A study of milk-borne disease outbreaks reveals the importance of health of the dairy worker.

3. **Clean and Sanitized Utensils**—Improperly cleaned and sanitized utensils may be the sources of many bacteria and may easily transform a high-quality milk to an inferior or even an unacceptable product. To demonstrate the value of proper cleaning and sanitization, rinse counts were made of utensils ready for use as found on the farm. A few days later an unannounced visit was made to each farm. This time the utensils were sanitized with a chlorine solution (50 p.p.m.), allowed to drain for 30 minutes, and were then rinsed with sterile sodium thiosulfate water to inactivate the remaining chlorine. Bacteria counts were made of all of these rinsings to determine the number of bacteria removed by the water (Table 4). Normally these bacteria get into the milk as the utensils are used during the milking process. These data are convincing evidence of the value of sanitization of all dairy utensils, especially those on the farm. Clean utensils have very few bacteria on their surfaces and, therefore, will not contribute many bacteria to the milk handled therein.

4. **Prompt and Efficient Cooling**—Milk is a good food for bacteria as well as for man and other animals. As it comes from the cow it is at a temperature ideal for multiplication of the bacteria that gain access to the milk. According to the data in Table 5, the practical procedure for dealing with these bacteria is to cool the milk immediately to 50° F. or lower and to hold it at that point until it goes to the receiving station.

5. **An Adequate Water Supply That Is Both Satisfactory and Safe**—Dairy animals need a constant supply of clean and fresh drinking

TABLE 5—*Bacteria counts of milk obtained upon the storage of milk at different temperatures for varying periods of time when cooled to those temperatures immediately after production*

Period of storage	Bacteria count of the milk							
	Original count 5,000				Original count 100,000			
	Temperature of immediate cooling and storage of milk							
	40° F.	50° F.	60° F.	70° F.	40° F.	50° F.	60° F.	70° F.
5 hours....	5,000	5,000	5,000	7,500	100,000	100,000	100,000	340,000
10 hours....	5,000	5,000	6,000	28,000	100,000	100,000	180,000	870,000
15 hours....	5,000	5,000	12,000	200,000	100,000	150,000	300,000	2,000,000

water if they are to produce at a maximum. A similar water supply is essential for the proper cleaning of dairy utensils and for the cooling and storage of milk. Occasionally the water supply, used for these purposes, becomes contaminated with specific types of bacteria that produce undesirable changes in the milk besides being objectionable merely because of their presence. The ropy milk bacteria come under this category.

A review of two experiences will direct our attention to some of the aspects of overcoming the ropy milk problem. An outbreak of ropy milk presents the following two characteristics: 1) The milk is normal in physical appearance as it is obtained from the cows, and 2) A tenacity of the contaminated milk, and especially the cream, develops within 12 hours if the milk is not properly cooled. Several organisms, including some of the coliform group, are capable of causing ropy milk but the main one is *Alcaligenes viscosum.* The original source is not always known, but stagnant water in the barnyard or pasture should be immediately suspected, while the immediate source is usually the coat of the cow or surface water that gains entrance to the well water.

In one case studied the milk apparently became contaminated, during milking, from the exterior of the cow. The cows were immediately prevented from gaining access to stagnant water in the pasture where they had gone to keep cool during the summer heat, but the ropy milk trouble continued. A thorough check-up revealed that the farmer always rinsed the stirring rod in the cooling tank between cans

and between milkings. Thus the cooling tank water was inoculated from the contaminated milk on the stirrer. As a result of this insanitary practice the cooling tank water became heavily inoculated and, through the stirring rod, became the immediate source of subsequent contamination of the daily milk. A thorough cleansing and disinfection of the cooling tank and discontinuance of the practice of rinsing the stirring rod in the cooling water overcame the difficulty on this farm.

The second case was very similar insofar as the original source and its elimination were concerned. It was dissimilar in that the farmer did not rinse the stirrer in the cooling tank water, yet ropiness appeared rather consistently by morning in his night's milk. The contaminated area was in the poorly drained barnyard. On this farm the milkhouse was situated directly over the well which was the source of water used for washing and rinsing equipment and for the cooling of the milk. The concrete cover of the well, which was also the floor of the milkhouse, had a crack in it so that water from the milkhouse could seep back into the well. Apparently the milkhouse floor became inoculated with ropy milk bacteria from the farmer's shoes. This inoculum had an opportunity to build up in the well by the daily addition of contaminated water from the floor. Since no chemical sanitizer was used as a final treatment of dairy utensils on this farm and since the dairy detergent did not inactivate the ropy milk organisms the utensils were always contaminated and served to inoculate the milk. To overcome the chain of contamination, a new well cover was installed. The working surfaces of the milkhouse and cooling tank were thoroughly cleaned and then disinfected with a chlorine solution. A strong chlorine solution was prepared (1 pound of chlorine powder containing 15 percent available chlorine was dissolved in 5 gallons of water) and placed into the well. After one hour the pump was run for 15 minutes to draw this water through the pump and pipes. Apparently this served to destroy the ropy milk bacteria because none could be recovered from the water after this treatment, and no more ropy milk troubles were experienced.

SUMMARY

Application of these five essentials to milk production will go a long way towards realizing a safe milk of high quality:

1. Clean and healthy cows.
2. Clean and healthy handlers.
3. Clean and sanitized dairy utensils.
4. Prompt and efficient cooling.
5. An adequate water supply that is both satisfactory and safe.

FIELD TESTS WITH SEED SAVER DUST IN CONTROL OF STINKING SMUT OF WHEAT

By J. H. MUNCIE
SECTION OF BOTANY AND PLANT PATHOLOGY

AT VARIOUS TIMES since 1930, the Section of Botany and Plant Pathology has carried on tests of fungicides as seed treatments for combatting stinking smut or bunt of wheat.

In August 1946, the Parsons Chemical Works submitted a sample of their "Seed Saver Dust" for tests on control of stinking smut. A series of plots of smutted wheat (variety Bald Rock), treated with (a) this material and (b) with New Improved Ceresan-treated and untreated smutted wheat seed as checks were planted in Field 19 on October 26, 1946.

DOSAGE OF STINKING SMUT SPORES

In tests of this type a standard procedure (1) is followed, in which smut spores sifted through an 80-mesh screen are applied to the clean wheat seed before the disinfectant treatment is made. In these tests spores at the rate of 1 part by weight to 200 parts of untreated clean wheat were applied as the standard dosage. Smut spores and wheat were thoroughly mixed mechanically until the wheat kernels were distinctly darkened by the adhering inoculum.

DOSAGE OF DISINFECTANT

The dosage of disinfectant used was that recommended by the manufacturer of the disinfectant, namely ½ ounce disinfectant to one bushel of wheat. The disinfectant was thoroughly mixed with the smutted wheat in a glass container by shaking and rotation. Examination of the treated wheat showed disinfectant coating each kernel more or less completely.

ARTICLE 30-36

LAY-OUT OF PLOTS

The plots were laid out in 8-foot rows as follows:

Plot 1	Parsons Seed Saver	5 rows
2	Check (smutted wheat)	5 rows
3	Ceresan	5 rows
4	Parsons Seed Saver	5 rows
5	Check (smutted wheat)	5 rows
6	Ceresan	5 rows
7	Parsons Seed Saver	10 rows

The wheat was planted by hand 24 hours after the disinfectant was applied to the smutted seed. The disinfected seed of each material was planted separately and the untreated smutted seed planted last.

RESULTS OF SEED TREATMENT TESTS

Counts were made of the smutted and clean wheat heads on the three center rows of each plot on August 8, 1947. Results of these counts are given in the following table:

Treatment	Number wheat heads counted			Percentage with smut
	Clean	Stinking smut	Total	
1 Parsons Seed Saver	195	45	250	18.0
2 Untreated check	93	79	172	45.9
3 New Improved Ceresan	65	0	65	0.0
4 Parsons Seed Saver	82	12	94	12.7
5 Untreated check	80	31	111	27.9
6 New Improved Ceresan	108	4	112	3.6
7 Parsons Seed Saver	53	24	77	31.2

Results of these tests show that the average percentage of bunt or stinking smut for the treatments was as follows:

Untreated smutted check	38.80 percent
Parsons Seed Saver Dust	19.24 percent
New Improved Ceresan	2.26 percent

DISCUSSION

Although heavy stinking smut infection of wheat is not a common occurrence in Michigan, the writer has examined fields in which infection ranged from 10 to 60 percent. The average percentage in-

fection on the untreated smutted check plots is not unduly high. Temperature, moisture, strain of the stinking smut fungus and relative susceptibility of the wheat all enter into the results of a field test of this type. In this case there was a decided lack of soil moisture after the plots were planted, which probably lessened spore germination and resulting infection.

CONCLUSIONS

It is obvious from these tests that Parsons Seed Saver Dust applied at the rate of ½ ounce per bushel gave decidedly inferior control of stinking smut, as compared with New Improved Ceresan used at the same rate of application. Under similar conditions of natural heavy infection of the seed, Parsons Seed Saver would be entirely inadequate in controlling stinking smut or bunt.

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COST AND RETURN FACTORS IN DAIRY PRODUCTION IN 1946

By E. H. CARTER *and* W. H. VINCENT
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PRODUCTION COSTS on individual herds varied from \$2.84 to \$9.68 per 100 pounds of milk in 1946 in the Detroit milkshed. Why did it cost some dairymen 3 to 4 times as much to produce milk as it did other dairymen? A dairy cost study, cooperative between the Michigan Milk Producers Association and the Farm Management Section, has helped to provide the answer to this question.

Average production per cow, butterfat test, size of herd, labor requirements, feed requirements, and major costs and returns for the

TABLE 1—*Milk production cost and income per 100 pounds, southeastern Michigan, 1945-46*

Item	1945	1946
Number of cooperators	105	95
Milk production per cow (lb.)	8,250	8,190
Butterfat production per cow (lb.)	303	303
Butterfat test (%)	3.67	3.71
Cows per herd	17	16
Hours labor per cow for year	132	132
FEED FED PER COW IN YEAR		
Concentrates (lb.)	3,250	2,840
Hay (lb.)	4,170	4,340
Silage (lb.)	4,400	5,080
Other roughage (lb.)	170	500
Pasture (days)	139	149
COSTS PER 100 POUNDS MILK		
Feed	\$1.79	\$1.97
Labor	1.19	1.35
All other items*	.80	.84
Total	\$3.78	\$4.16
INCOME PER 100 POUNDS MILK		
Milk sold and used	\$3.24	\$4.08
Other credits	.66	.31
Total	\$3.90	\$4.39
NET RETURN PER 100 POUNDS MILK	\$0.12	\$0.23

*Include cow depreciation, interest on cows, building and equipment use, breeding, bedding, electricity, veterinary, miscellaneous cash expenses, and an estimated share of such general expenses as auto, telephone, etc.

ARTICLE 30-37

first 2 years of the study are shown in Table 1. Coincidentally, the average figures for labor requirements and butterfat production are identical for 1945 and 1946. Averages for milk production, butterfat test and size of herd were about the same for the 2 years. As for feed costs, the value of the feed was entered at farm price if produced on the farm, and at actual cost if purchased. Hired labor was entered at actual cost. The cooperator entered what he thought a fair charge for both his time and time spent by the family in the dairy business. "Other" income consisted of calves, manure, and subsidy payments.

PRODUCTION PER COW

Variations in Production—Average butterfat production a cow per herd basis for individual herds in this study varied from 212 to 408 pounds in 1946. Annual milk production per cow averaged 8,190 pounds and ranged from 5,300 to 11,420 pounds. About 15 percent of the herds produced annually less than 250 pounds of butterfat, and about 15 percent produced more than 350 pounds of butterfat per cow (Table 2). This variation in production is largely explained by influences within the control of the individual farmer.

Feed Fed Per Cow—Cows in herds averaging over 350 pounds of butterfat consumed about 50 percent more concentrates, 10 percent more barn-fed roughages and about the same pasture as the cows in herds averaging less than 250 pounds of butterfat. The additional feeding resulted in a $37 higher feed cost per cow, but higher production made a 12-cent less feed cost per pound of butterfat and a 20-cent less cost per hundredweight of milk produced.

Labor Costs and Returns—In this study the total cost of labor was 22 percent higher in the herds averaging more than 350 pounds of butterfat than in the herds averaging less than 250 pounds of butterfat per cow. This is due to 10 percent more hours spent and a 12-percent higher labor rate in the high-producing herds. However, the effect of labor rate is less pronounced when herds with butterfat yields above and below 300 pounds per cow are compared. In this comparison the higher producing group required 10 percent more hours per cow, but the hourly labor rate was only 6 percent more than the lower producing group. Thus, it was seen that both quantity and quality of labor (as indicated by rate) varied among different production levels.

Increased returns per cow more than compensated for the additional costs apparently necessary for higher production. Although the

labor cost per cow was $22 more in the 15 high-producing herds than in the 14 low-producing herds, the labor cost per pound of butterfat was 9 cents less and per hundred pounds of milk produced was 19 cents less in the high-producing herds.

The herds producing less than 250 pounds of butterfat had low average costs per cow but returns lacked $1.13 per cow of paying all costs. The herds averaging over 350 pounds of butterfat paid all costs and had $34 per cow to spare. The return an hour of operator's labor for the high- and low-producing herds was $1.34 and 93 cents, respectively. Thus, in terms of returns, the operator's time had a 41-cent an hour higher value on the farms with higher dairy production. These figures show rather definitely the positive relationship of high returns to high production.

TABLE 2—*Production per cow and its influence in dairy costs and returns in southeastern Michigan, 1946*

Item	Pounds butterfat produced per cow				
	Under 250	250-299	300-349	Over 350	All herds
Number of herds	14	30	36	15	95
Number of cows per herd	16	16	16	17	16
Butterfat production per cow	232	281	323	367	303
Milk production per cow	6,510	7,760	8,760	9,150	8,190
Butterfat test (calculated)	3.56	3.62	3.69	4.01	3.71
FEED FED PER COW					
Concentrates (lb.)	2,253	2,940	3,037	3,334	2,840
Hay (T.)	2.3	2.2	2.1	2.2	2.2
Silage (T.)	1.6	3.0	2.7	2.2	2.5
Other roughage (lb.)	614	540	429	296	503
Pasture (days)	165	142	143	162	149
Labor hours, total per cow	111	130	147	122	132
Labor hours by operator per cow	92	88	92	110	94
COSTS PER COW*					
Feed	$136.02	$159.14	$168.05	$173.15	$161.45
Labor	98.05	104.15	115.35	120.33	110.20
Depreciation	....	2.87	5.83	10.77	4.27
Other items	53.80	58.79	65.84	80.47	64.30
Total	$287.87	$324.95	$355.07	$384.72	$340.22
INCOME PER COW					
Milk sold and used	257.53	312.11	354.56	393.31	333.63
Subsidy	10.21	10.06	10.92	8.52	10.16
Calves at 5 days	7.37	5.86	8.28	8.63	7.47
Manure	7.55	9.62	8.00	8.13	8.45
Appreciation	4.08	....	....	....	....
Total	$286.74	$337.65	$381.76	$418.59	$359.71
Net return per cow	−1.13	12.70	26.69	33.87	19.49
Total cost per pound of butterfat	1.25	1.17	1.11	1.06	1.12
Income per pound of butterfat	1.25	1.21	1.19	1.15	1.18

*Costs include feed at farm prices, labor at an average of 83 cents an hour, and all other items at current prices.

SIZE OF HERD

Variations in Size of Herd—The range in number of cows per herd in the herds studied in 1946 was from 6 to 37. Approximately 50 percent of the dairymen had herds smaller than 15 cows and the most common herd size was 12 cows.

The greatest effects from variation in herd size were on the labor hours per cow, labor rate, and barn and equipment costs per cow. Little effect was noticed on average butterfat production per cow or breeding costs per cow. Feed costs were higher on herds with 25 or more cows, probably because of the somewhat higher milk and butterfat production of these herds.

Labor Requirements—The labor requirement per cow was especially affected by size of herd. An average of 68 hours was spent per cow in herds consisting of 25 or more cows, or 58 percent less than in the herds smaller than 10 cows. Although the average hourly labor charge made by the farmer was 24 cents higher for the large herds, the superior labor efficiency on these farms resulted in a saving of $18 per cow in labor costs. In other words, the time spent on each cow in the large herds was enough less to more than pay for labor of higher charge per hour.

Labor Rate—The differences in the labor rate in various size herds is probably explained by the extent that dairying dominated the operator's interests. It is likely that herds smaller than 10 cows supplemented some other farm enterprise, and that herds larger than 25 cows constituted the major enterprise of those farms. To this extent, the value given labor varied among herds of different size. The average labor rate was also affected by the extent that labor besides that of the operator was used. The amount of hired and family hours spent per cow increased steadily from 19 percent of total labor in herds smaller than 10 cows to 43 percent of total labor in herds having more than 25 cows. The value of hired and family labor increased with its need. The average charge for hired and family labor varied from 47 cents an hour in the smallest herds to 63 cents an hour in the largest herds.

Building and Equipment Use—The investment per cow and the cost of using buildings and equipment per cow was highest in the herds smaller than 10 cows and steadily decreased in larger herds except those larger than 25 cows (Table 3). It is possible that the 10

TABLE 3—*Size of herd and its influence on cost and returns, southeastern Michigan, 1946*

Item	Average number of cows per herd					
	Under 9.9	10-14.9	15-19.9	20-24.9	25 and over	All herds
Number of herds	17	30	24	14	10	95
Average number cows per herd	8	12	18	22	31	16
PRODUCTION PER COW						
Milk (lb.)	7,390	7,980	8,110	8,110	8,960	8,190
Butterfat (lb.)	298	297	298	312	316	303
LABOR						
Total hours per cow	185	133	133	123	117	132
Operator hours per cow	151	104	101	74	67	94
Charge per hour (all labor)	$ 0.66	$ 0.85	$ 0.87	$ 0.81	$ 0.90	$ 0.83
Operator charge per hour	.71	.94	.95	.96	1.10	.94
INVESTMENT PER COW						
Barn	292.00	232.00	152.00	123.00	214.00	190.00
Equipment	33.00	30.00	28.00	18.00	27.00	27.00
COSTS PER COW						
Feed	147.12	157.61	161.36	160.10	173.78	161.45
Labor	123.11	112.85	115.38	99.54	105.02	110.20
Depreciation (net)	2.01	2.60	6.65	3.23	6.41	4.27
Building use	13.92	10.36	8.30	6.65	11.47	9.58
Equipment use	8.45	6.87	6.52	4.59	5.82	6.25
Breeding costs	9.09	10.89	9.99	9.20	8.72	9.72
Other items	38.09	37.90	37.23	38.10	42.79	38.75
Total	$341.79	$339.08	$345.43	$321.41	$354.01	$340.22
INCOME PER COW						
Milk sold and used	311.31	328.59	326.95	333.91	358.39	333.63
Subsidy	9.74	9.94	10.64	10.00	10.13	10.16
Calf value at 5 days	8.52	6.77	7.28	8.06	7.51	7.47
Manure	11.35	9.25	8.66	6.55	7.82	8.45
Total	$340.92	$354.55	$353.53	$358.52	$383.85	$359.71
RETURNS						
Net return per cow	0.87	15.47	8.10	37.11	29.84	19.49
Per hour (all labor)	.66	.97	.93	1.11	1.15	.98
Per hour operator labor	.70	1.09	1.03	1.46	1.55	1.14

herds with more than 25 cows were less efficient in the use of equipment and additional building space or used more elaborate and expensive barns and equipment.

Costs and Returns—The herds smaller than 10 cows failed by 87 cents a cow of paying all costs, while the herds larger than 25 cows paid all cost and left about $30 a cow to spare. The hourly labor return was 49 cents higher in the large herds than in the small herds. Respectively, these returns were $1.15 and 66 cents an hour for all labor; when labor returns for the herds were compared, they were about $3,000 higher in the 31-cow herds than in the herds averaging 8 cows. This includes payment for all labor including hired, family and operator's labor. Thus, operators of the large herds in this study used their resources more efficiently and realized higher returns.

LABOR EFFICIENCY

Labor hours per cow varied widely and, for the most efficient fifth of the farmers, amounted to less than half as much as in the case of the least efficient fifth (Table 4). The efficient use of labor reduced costs.

The 19 low-hour dairymen averaged 92 hours per cow as compared with 204 for the 19 high-hour dairymen. Labor cost per cow averaged $90 for the low-hour group and $143 for the high-hour group. The more efficient operators charged more for their time. Labor cost per 100 pounds of milk averaged $1.12 for the low-hour group as compared with $1.64 for the high-hour group.

Total costs per cow for the two groups were $328 and $405, respectively. Labor cost amounted to only 27 percent of total costs for the most efficient group, even though the operators charged more for their time, as compared with 35 percent for the least efficient group. Operator labor comprised 94 percent of total labor costs for the low-hour dairymen as compared to 70 percent for the high-hour dairymen. The tendency for high-labor efficiency to be associated with a high proportion of operator labor costs is also shown in the other groupings.

The return per hour of labor was $1.34 for the dairymen averaging 92 hours a cow as compared with 63 cents for those dairymen averaging 204 hours a cow. Similarly, the net return per cow (after deducting labor costs) amounted to $33 for the most efficient group, whereas the least efficient group lacked $14 of paying costs.

Production per cow did not vary greatly within the groupings. It was, however, slightly higher for the dairymen spending the most time (8,730 pounds of milk compared with 8,020 pounds for the most efficient dairymen). Thus, in spite of higher production, returns an hour were less for this high-hour group. According to Table 4, the more efficient dairymen tended to have herds of about 17 to 19 cows as compared with 13 for the less efficient dairymen. Apparently 17 to 19 cows are required for an efficient unit of operation.

Inasmuch as high labor efficiency was associated with lower costs, an attempt was made to discover why some farmers did the job in less time than did others. The more efficient dairymen apparently did a more thorough job of planning barn arrangement and chores and of using labor-saving equipment, as evidenced by a comparison of certain chore practices. "Managed" milking, at least in part, was practiced

TABLE 4—*Relation of labor efficiency to costs and returns, 1946*

Item	Hours labor per cow					
	79-108	109-120	121-136	137-166	167-437	All herds
Number of herds	19	19	19	19	19	95
Cows per herd	19	17	20	13	13	16
Labor hours per cow	92	114	127	150	204	132
B.F. production per cow (lb.)	302	298	304	291	328	303
Milk production per cow (lb.)	8,020	7,900	8,250	8,160	8,730	8,190
COSTS PER COW						
Labor	$ 90.06	$101.90	$108.81	$119.53	$142.85	$110.20
Total	328.08	323.85	336 93	340.87	404.96	340.21
LABOR COSTS						
Percent of total cost	27	31	32	35	35	32
Percent operator's labor	94	86	70	80	70	80
Average labor rate of oper.*	$ 0.99	$ 0.95	$ 0.92	$ 0.95	$ 0.80	$ 0.94
Labor cost per cwt. of milk	1.12	1.29	1.32	1.46	1.64	1.35
RETURN, HOUR LABOR	1.34	1.15	1.02	0.92	0.63	0.98
NET RETURN PER COW	33.19	29.14	21.51	17.95	−14.50	19.50

*Simple average.

by 58 percent of the operators spending less time as compared with 37 percent of the operators spending more time. There was a tendency for the low-hour farmers to use grain and silage carts in feeding. There was also a tendency for the low-hour dairymen to use litter carriers rather than wheelbarrows or to fork the manure from the stable by hand.

The breed of cows was not associated with labor efficiency. Length of pasture season was not a prime factor in determining labor efficiency. In fact, study indicated that the high-hour dairy farmers had their cows on pasture a month longer than did the low-hour dairy farmers.

This study indicates that labor requirement per cow can, in some cases, be reduced by as much as 50 percent. The amount of labor required can be reduced by better chore planning, the adoption of labor-saving equipment, and a more convenient arrangement of the barn.* In some cases, more cows should be added to the herd to effect an efficient unit of operation, as previously discussed. By decreasing labor costs, it would be possible for some dairymen to realize as much as 70 cents more an hour for labor spent in the dairy enterprise.

*For further information, see *Reducing Chore Labor on Dairy Farms* by B. R. Bookhout, Mich. Agr. Exp. Sta. Quart. Bull. *30* (1): August 1947.

A NON-TOXIC PLASTIC COATING TO IMPROVE THE KEEPING QUALITY OF CUT FOLIAGE

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SECTION OF HORTICULTURE

A PLASTIC MATERIAL, called Geon 31X, which has been recently developed by the Goodrich Chemical Company, has been tested on various cut evergreen branches, mistletoe, and Christmas trees. It has proved valuable as a means of preserving the natural attractive appearance of the plant materials for a considerable time when applied as a spray coat on their surfaces.

Cut plant materials are used extensively for decorative purposes. Evergreens, ferns, and deciduous foliage are used by florists in making wreaths and floral displays, and holly, mistletoe, and evergreen trees are used during the Christmas holiday season.

One great difficulty in handling cut plant material is its rapid wilting and drying out. Coincident with water loss is the shrivelling of tissues, loss of attractive appearance and, in many cases, loss of leaves or needles very readily after being cut.

Many attempts have been made to improve the appearance and keeping quality of cut plant material. Various degrees of success have been obtained by placing the cut stems under water, by waxing the foliage to reduce transpiration, by increasing the moisture of the surrounding air, and by refrigeration of the plant material.

It is believed by the authors that a material has now been found that will greatly improve the keeping quality of certain kinds of cut foliage. The material is a non-toxic, moisture-proof, plastic material called Geon 31X. It is a water-dispersable poly-venyl resin which upon drying leaves a transparent film with a low-vapor-moisture transmission, which will stretch considerably before it tears. Further, the material will not burn nor support combustion and, when subjected to a flame, it only chars; hence, plant material sprayed with Geon 31X tends to become somewhat fire resistant.

ARTICLE 30-38

EXPERIMENTAL

The experiments described were carried out at the College, during the period October 29-December 31, 1947.

Preliminary trials indicated that for Norway spruce *(Picea excelsa)* a spray containing Geon 31X at a concentration of 10 percent of solid material was most desirable. As a result of these preliminary findings, most of the subsequent tests were conducted with a 10-percent solution of Geon. Following advice of the Goodrich Company, a wetting agent was added to the Geon to insure better coverage on plant material.

An experiment was carried out with cut branches of Norway spruce *(Picea excelsa)*, Chinese arborvitae *(Thuja orientalis)*, American arborvitae *(Thuja occidentalis)*, and White pine *(Pinus strobus)*. Twenty uniform bundles of branches from each group were selected and weighed. Ten bundles from each group were treated with a 10-percent solution of Geon by spraying the solution onto the foliage until complete saturation was obtained. Ten bundles from each group were left untreated as checks. The treated bundles; together with those untreated, were then hung in a room in which the temperature was maintained at 85° F. with a humidity of 20 percent. The branches were then weighed at intervals to determine the amount of water lost from each group. The results are tabulated in Table 1. Untreated plants in most cases lost considerably more water than did treated

TABLE 1—The effect of Geon 31X treatment on water loss of cut branches of Norway spruce *(Picea excelsa)*, Chinese arborvitae *(Thuja orientalis)*, and White pine *(Pinus strobus)*

Material	Treatment	Water loss (percent of total weight)		
		Nov. 10	Nov. 13	Nov. 18
Norway spruce	Geon, 10 percent	0	23	48
	Untreated	0	36	61
Chinese arborvitae	Geon, 10 percent	0	20	42
	Untreated	0	31	51
Chinese arborvitae	Geon, 10 percent	0	29	51
	Untreated	0	42	55
White pine	Geon, 10 percent	0	16	36
	Untreated	0	30	51

TABLE 2—Effect of Geon treatment on water loss of cut branches of Norway spruce *(Picea excelsa)* and American arborvitae *(Thuja occidentalis)*

Material	Treatment	Water loss (percent of total weight)		
		Nov. 22	Nov. 23	Dec. 1
Norway spruce	Geon, 10 percent........	0	10	49
	Untreated..............	0	21	67
American arborvitae	Geon 31X, 10 percent....	0	17	53
	Untreated..............	0	18	55

plants. Untreated Norway spruce, for example, lost 61 percent of its weight, whereas the treated plants lost only 48 percent of their weight.

This experiment was repeated at a later date using only material of Norway spruce and American arborvitae, and results are recorded in Table 2.

Tests were also run with mistletoe *(Viscum album).* Ten branches of mistletoe were sprayed with a 10-percent solution of Geon, and 10 were left untreated as checks. Weights were taken at intervals to determine water loss and are given in Table 3.

To obtain information on how this new material would work on Christmas trees, trees of Norway spruce 5-7 feet tall were cut, selected for uniformity, divided into four lots of three trees each, and treated in the following way: 1) Sprayed with a commercial wax "A"; 2) sprayed with a commercial wax "B"; 3) sprayed with a 10-percent Geon 31X solution; and 4) left untreated as checks. The trees were then placed in a room in which the temperature was maintained at 85° F. and the humidity at 20 percent. Observations were taken at daily intervals and difference between treatments noted.

Treatments with commercial waxes were not so effective in preventing needle drop and, in addition, commercial wax "A" caused

TABLE 3—Water loss on branches of mistletoe *(Viscum album)* treated with Geon 31X

Material	Treatment	Water loss (percent of total weight)		
		Nov. 19	Nov. 20	Nov. 22
Mistletoe	Geon, 10 percent........	0	20	41
	Untreated..............	0	10	22

Fig. 1 (left). Cut Norway spruce tree 10 days after spraying with a protective coating of 10-percent Geon (Compare with Fig. 2)

Fig. 2 (right). Cut Norway spruce tree not sprayed with a protective coating (check) (Compare with Fig. 1)

marked browning of the needles after 5 days. The untreated trees, as well as those treated with the commercial waxes, started to drop their needles after 4 days and severe dropping was noted after 10 days. The trees treated with a 10-percent solution of Geon 31X maintained a fresh appearance throughout the 10-day trial and dropped only a very few needles.

Subsequent tests using smaller trees of Norway spruce completely confirmed the results that were obtained with the Geon material.

LENGTHENING THE LIFE OF CUT FLOWERS AND FLORAL GREENS BY THE USE OF PLASTIC COATINGS

By C. H. SHERWOOD and C. L. HAMNER
SECTION OF HORTICULTURE

THE LIFE of Christmas trees and cut branches of conifers used for decorative purposes has been lengthened by coating with a spray of a plastic material (Geon 31X). This material has proved useful in lengthening the life of certain flowers and floral greens as reported in the following paragraphs.

RESULTS WITH GARDENIAS

Striking results have been obtained with gardenias. In the initial experiment 12 gardenias were used; 4 were dipped in a 10-percent solution of Geon, 4 were dipped in a 20-percent solution, and 4 were left untreated. The flowers were then left out of water at room temperature (70° to 80° F.) and observed at intervals.

After 4 hours, untreated gardenia flowers began to wilt; and after 12 hours, in addition to being badly wilted, they had developed an objectionable yellowish brown color. Flowers treated with a 20-percent solution of Geon remained turgid and in excellent condition for about 36 hours, after which deterioration was quite rapid (Fig. 1). Flowers treated with a 10-percent solution remained fresh and attractive for 20 to 36 hours longer than untreated flowers. It appears from this test that the 20-percent concentration of Geon is best for gardenias.

The treatment with Geon in no way detracted from the natural beauty and appearance of the flowers. It was felt by many observers that the appearance of the flowers was improved by the treatment. Some loss in fragrance occurred from the treatment, but this loss was not great and was not undesirable.

ARTICLE 30-39

Fig. 1. Gardenia flowers showing effect of treatment with Geon 31X. Upper flower treated by being dipped into 20-percent Geon 31X solution. Lower flower untreated. (Photographed 24 hours after treatment.)

TABLE 1—*Water loss from gardenia flowers following treatment with Geon 31X*

Material	Treatment	Weight loss in percent 4 hours after treatment
Gardenia	Geon 31X, 10 percent..........	6.2
	Geon 31X, 20 percent..........	4.5
	Untreated..................	13.0

Water loss was reduced by the treatment, and this probably partially accounts for the fresh appearance of the flowers. Table 1 shows water loss at the end of 4 hours. At this time the control flowers were beginning to wilt.

RESULTS WITH FERN ASPARAGUS

Fern asparagus *(Plumosus asparagus)* is extensively used as a decorative green. It has one drawback, however, and that is a tendency to lose leaflets shortly after being cut. Branches from the fern asparagus were selected, divided into 30 bundles, and treated by dipping in water solutions of Geon 31X at various concentrations. Ten bunches were treated with 5-percent Geon, 10 bunches with 10-percent Geon, and 10 left untreated. The ferns were then placed in a warm room (85° F.) and the loss of weight was recorded at intervals. After 2 or 3 days, 20 to 30 percent of the leaflets from untreated plants had dropped, while on plants treated with 10-percent Geon the dropping was almost negligible over a 10-day period. Water loss was also reduced as a result of treatment as is shown in Table 2.

RESULTS WITH OREGON FERN

Oregon fern *(Polystichum acrostichoides)* is a decorative plant material, that, undoubtedly, would have more extensive use if it would last longer. Fronds from Oregon ferns were divided into 30 bundles. Ten

TABLE 2—*Water loss from fern asparagus following treatment with Geon 31X*

Material	Treatment	Weight loss in percent		
		Nov. 18	Nov. 19	Nov. 20
Plumosus asparagus	Geon 31X, 5 percent....	0	18	43
	Geon 31X, 10 percent....	0	5	23
	Untreated..............	0	35	66

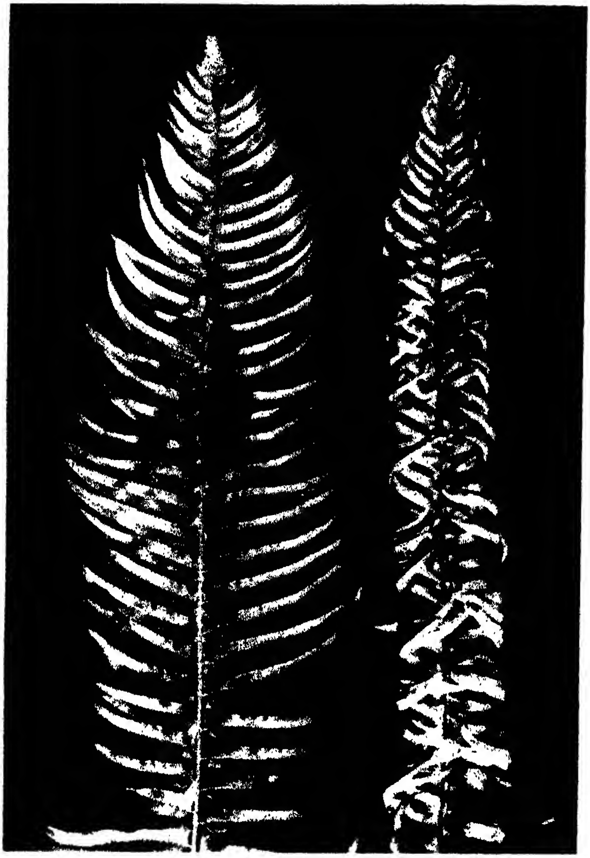

Fig. 2. Oregon fern showing effect of Geon treatment. Frond on the left treated with a 20-percent solution of Geon 31X. Frond on the right left untreated. (Photographed 24 hours after treatment.)

bundles were dipped in a 5-percent Geon solution, 10 bundles were dipped in a 10-percent Geon solution, and 10 were left untreated. The bundles were then taken into a warm room at 85° F. and records taken at intervals. After about 12 hours, untreated fronds (Fig. 2) began to wilt and shrivel, and by 24 hours were badly wilted. Fronds treated with 10-percent Geon remained turgid from 24 to 36 hours longer than did untreated fronds. Water loss was much greater in untreated fronds and probably accounted for the differences in wilting (Table 3).

TABLE 3—*Water loss from Oregon fern following treatment with Geon 31X*

Material	Treatment	Weight loss in percent	
		Nov. 20	Nov. 22
Oregon fern	Geon 31X, 5 percent	0	46
	Geon 31X, 10 percent	0	42
	Untreated	0	60

Another experiment on Oregon fern showed quite clearly that a 20-percent dip with Geon 31X would be much more effective than a 10-percent dip. Although records on water loss are not available for the 20-percent dip, the loss of water was undoubtedly far less than for the other treatments. The 20-percent dip made a somewhat heavy coating but this was not objectionable on the fern.

SOME STUDIES ON TEMPERATURE ADAPTATION IN THE BABY PIG

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REPORTS FROM the Midwestern states in the spring of 1947 indicated tremendous losses of baby pigs. Smith (1937) states that chilling accounts for 3 percent of the baby pig losses, which in terms of the estimated 1948 spring pig crop means that 2,000,000 baby pigs will die from chilling. The inability of young pigs to adjust themselves to low environmental temperatures will be a contributing factor in the death of pigs which are born weak, overlaid by the sow or die from other causes.

Experienced swine producers are familiar with the erect hair, shivering and huddling of cold young pigs. Observant caretakers also know that the lighter pigs at birth suffer more in cold weather than heavier pigs, often becoming cold to the touch and dying within the first day or two after birth.

In spite of the heavy losses from chilling and the importance of an understanding of the heat control mechanism in the baby pig, very little work has been done on this subject. The purpose of this paper is to present preliminary data collected in the spring and fall of 1947 covering: 1) the temperature responses of baby pigs under barn conditions, 2) the relation of birth weight to body temperature, and 3) the temperature responses of young pigs to low and high environmental temperatures.

EXPERIMENTAL PROCEDURE

Litters of Yorkshire, Duroc Jersey, Chester White and Yorkshire X Duroc Jersey crossbred pigs were used. The pigs were farrowed in 8- by 8-foot concrete pens that were bedded lightly with shavings, and equipped with a 200-watt bulb in an open brooder. In severe

[1]The authors acknowledge the suggestions of Dr. E. P. Reineke, Department of Physiology and Pharmacology, and Prof. G. A. Brown and Dr. R. H. Nelson, Department of Animal Husbandry.

weather an electric heater was used to keep the temperature above 50° F.

The first four pigs born in each litter were used. Upon birth the temperature of each pig was taken rectally with a clinical thermometer, inserted to a depth of 1.5 inches, and kept there for at least 60 seconds. After this initial temperature was taken, the pig was placed in a canvas sling with four suitably spaced holes for the feet. A piece of gauze bandage was then tied over the shoulders which held the pig in place. In most cases the pigs rested in these slings with a minimum of movement. The pig was then marked and further temperatures were taken at 10-minute intervals up to one hour. The pig was then removed from the sling and put back to nurse. Thereafter, when it was necessary to take temperatures, the pigs were held by the hind legs.

In studying the temperature responses of young pigs exposed to cold, a meat chilling room was used in which the temperatures ranged from 36° to 38° F. Pigs from two litters, 18 and 50 hours old, respectively, were allowed to run freely on the floor of the cooler, and temperatures were taken at half-hour intervals up to 3 hours.

For the heat response studies, a standard chick brooder was used in which the temperatures ranged from 118° to 120° F. The pigs remained in the brooder for 30 minutes.

DISCUSSION

The average temperature responses of 25 pigs under barn conditions show that the temperature of a new-born pig drops from 3° to 9° F. during the first hour after birth, with the average being about 4° F., as seen in Fig. 1. The sharpest drop occurs during the first 20 minutes of life, and by the time the pig is an hour old, there is a gradual increase toward normal. The average temperature of 25 pigs observed was 98° F. at 20 minutes, 100.5° at 10 hours, 101.5° at 24 hours, and 102.3° at 48 hours. At 2 days of age, the pigs had practically reached the temperature of their mothers, or 102.5° which is reported by Dukes (1943) as the normal body temperature for swine.

It may be seen from Fig. 2 that the temperature of the lighter pigs dropped faster than that of the heavier pigs. In the litters used, there was a positive intra-litter correlation of 0.71 between the birth weights of pigs and the drop in body temperature after birth. Although the data are limited, similar slopes of the regression lines of these

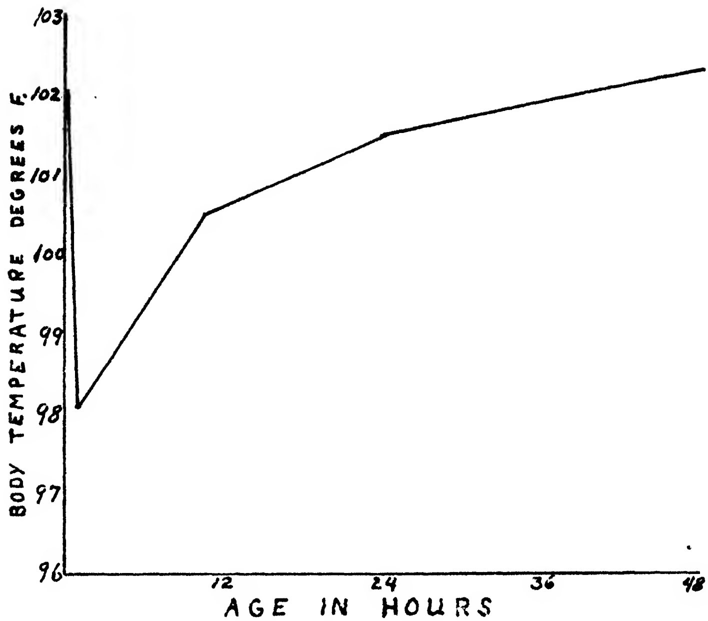

Fig. 1. Relation of age to body temperature in pigs up to two days old (average of 25 pigs).

litters and the high correlation coefficient give the data significance. These results would be expected from the work of Brody *et al.* (1945). He states that "The basal heat production per unit of body weight in homeotherms decreases rapidly with increasing weight." Also from the laws of Newton is derived the fact that the heat loss from a body is proportional to its surface area. These two statements translated into terms of this experiment seem to explain the greater temperature drop in the light pigs. This would be expected, as the lighter pig must produce more heat per unit of body weight to maintain normal temperature. The lighter pig also has proportionately more surface area from which to radiate heat than a larger pig.

These same general results were also observed in the chilling experiments in that the temperatures of the lighter pigs always dropped more than those of the heavier pigs. Four pigs from one litter 18 hours of age exposed to 34° to 36° F. for 3 hours showed a temperature drop of 2° to 4° F. depending upon the weight of the pig. Pigs of comparable weight 50 hours old were able to maintain a more nearly

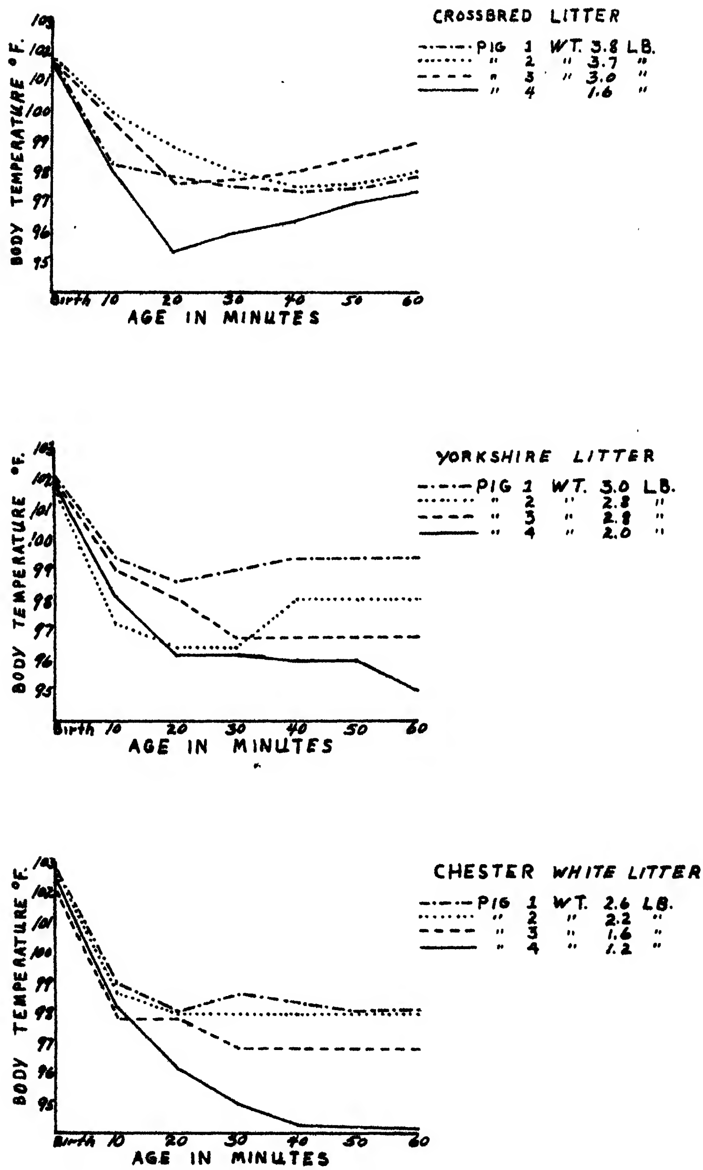

Fig. 2. Relation of body weight to temperature drop in baby pigs.

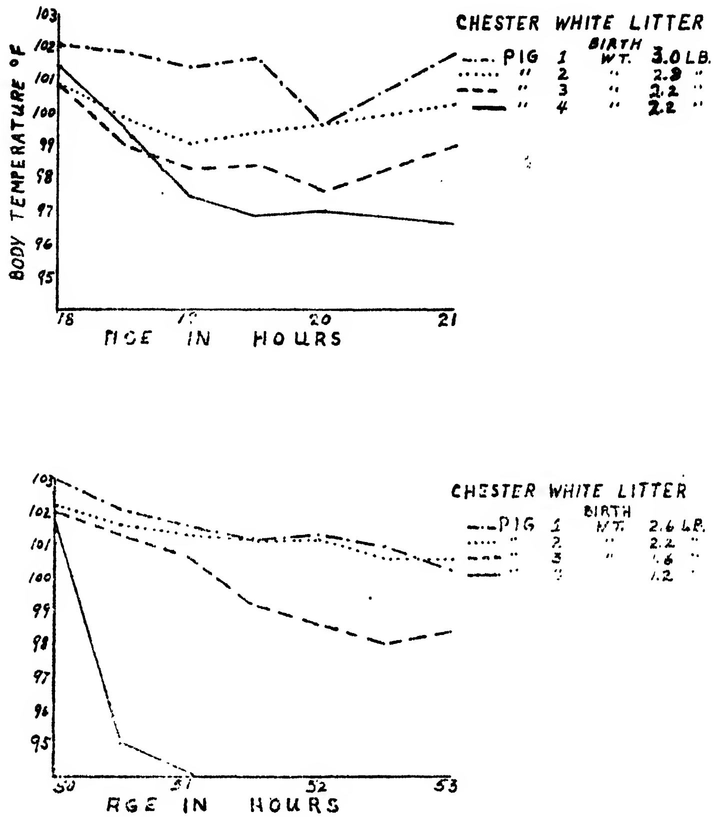

Fig. 3. Effect of chilling on body temperature in baby pigs (environmental temperature 36-38° F.).

normal temperature in the same environment (Fig. 3). This seems to indicate a more highly developed homeothermic mechanism in pigs 2 days old.

That baby pigs have no cooling mechanism capable of protecting them from excessive heat was shown when several baby pigs were placed in a chick brooder at 118° F. for a half-hour at 10 hours of age. Their body temperature rose 6° to 8° F., and the same result was observed on these pigs at 48 hours of age.

SUMMARY

1. There was a sharp drop of 3° to 9° F. in the body temperature of baby pigs immediately after birth.

2. This drop was followed by a gradual rise toward normal, which was completed at about 2 days of age.

3. At 2 days of age the heavier pigs withstood temperatures of 34° to 36° F. with less drop in body temperature than pigs of a younger age.

4. There was a significant correlation between the weight of a pig and its ability to adapt itself to its environment. Light pigs (under 2 pounds), because of greater surface area in proportion to body weight, must produce more heat per unit of body weight than heavier pigs and are unable to do this under severe conditions. They thus show a sharper drop in body temperature after birth, a slower recovery of normal temperature, and suffer first from chilling.

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RED CEDAR-APPLE AND HAWTHORN RUST DISEASE CONTROL BY SPRAYING RED CEDARS IN THE SPRING

By FORREST C. STRONG
SECTIONS OF BOTANY AND PLANT PATHOLOGY

THE RED CEDAR rust diseases are caused by fungi *Gymnosporangium juniperi-virginianae* and *G. globosum* which have rather complicated life histories. These parasitic fungi require alternately two host groups to complete their life cycles. On rust galls on red cedars (Fig. 1, middle left) are produced spores which bring about the infection of apple and hawthorn leaves. In lesions on the apple and hawthorn leaves (Fig. 1, lower right and left) are produced spores which, in turn, reinfect the red cedars.

The planting of susceptible red cedars and flowering apples and hawthorns in close proximity to each other in ornamental plantings in parks, cemeteries, nurseries and on private properties permits the rust diseases to increase in intensity until all of these species and varieties of trees may be killed. Usually there is so much injury to the foliage that the ornamental value of the trees is seriously affected. This is especially true of flowering apples and hawthorns.

Apple and hawthorn trees can be protected from the injurious effects of these rust diseases by the judicious use of suitable fungicides such as Fermate,[1] fixed coppers, or wettable sulfurs. Such protection is afforded orchard apples by the application of one of these fungicidal compounds in sprays or dusts in the regular program to prevent the development of the highly injurious apple scab disease of leaves and fruit. However, such spray applications are often impracticable or impossible in the case of ornamental plantings, and then it becomes necessary to spray the red cedars.

With this in mind, tests were conducted to determine whether a fungicide could be safely applied to red cedar trees in the spring to

[1]Fermate, a proprietary name for ferric dimethyldithiocarbamate.

ARTICLE 30-41

prevent the production of spores on rust galls, thus protecting nearby apple and hawthorn leaves from infection.

Of the eradicative type of fungicides, Elgetol[2] was selected (1) because it had been reported to have considerable penetrating action. Elgetol was tested at the rate of ½-, 1-, and 2-percent concentrations in water. In preliminary experiments the 1-percent concentration was found best. A laboratory examination of sprayed galls showed that the lower concentration killed spores already formed but did not prevent further extension of the spore horn and later formation of more spores. The 2-percent concentration killed all spores formed and prevented further spore development but caused very severe injury to the foliage.

Using a 1-percent concentration of Elgetol, the author tested a single application on two red cedar plantings, and two applications a season on one red cedar planting. The two applications resulted in severe foliage injury which the trees outgrew later in the season.

Sites used for these spray trials were selected in ornamental plantings (Fig. 1, middle right) containing *Juniperus virginiana* and varieties *ganaertii* and *glauca*, usually two to six trees in a group, with two or more susceptible hawthorns or flowering apples within a radius of 25 to 100 feet. The sites selected were located so that there were no other red cedar trees within one-half mile. The locations designated as Mary Mayo Hall and Glenmore each had Bechtel's crab trees nearby. In the case of the northeast campus location, one *Crataegus pinnatifida*, a very susceptible Chinese variety was located about 25 feet from the cedar group. At the Ionia Memorial (Fig. 1, middle right)

[2]Elgetol, a proprietary name for a 34-percent concentration of sodium dinitrocresylate.

Fig. 1.

Upper left—Telial horns extended about ⅛ inch. Not as yet gelatinized. Trees should be sprayed when the horns are in this condition.

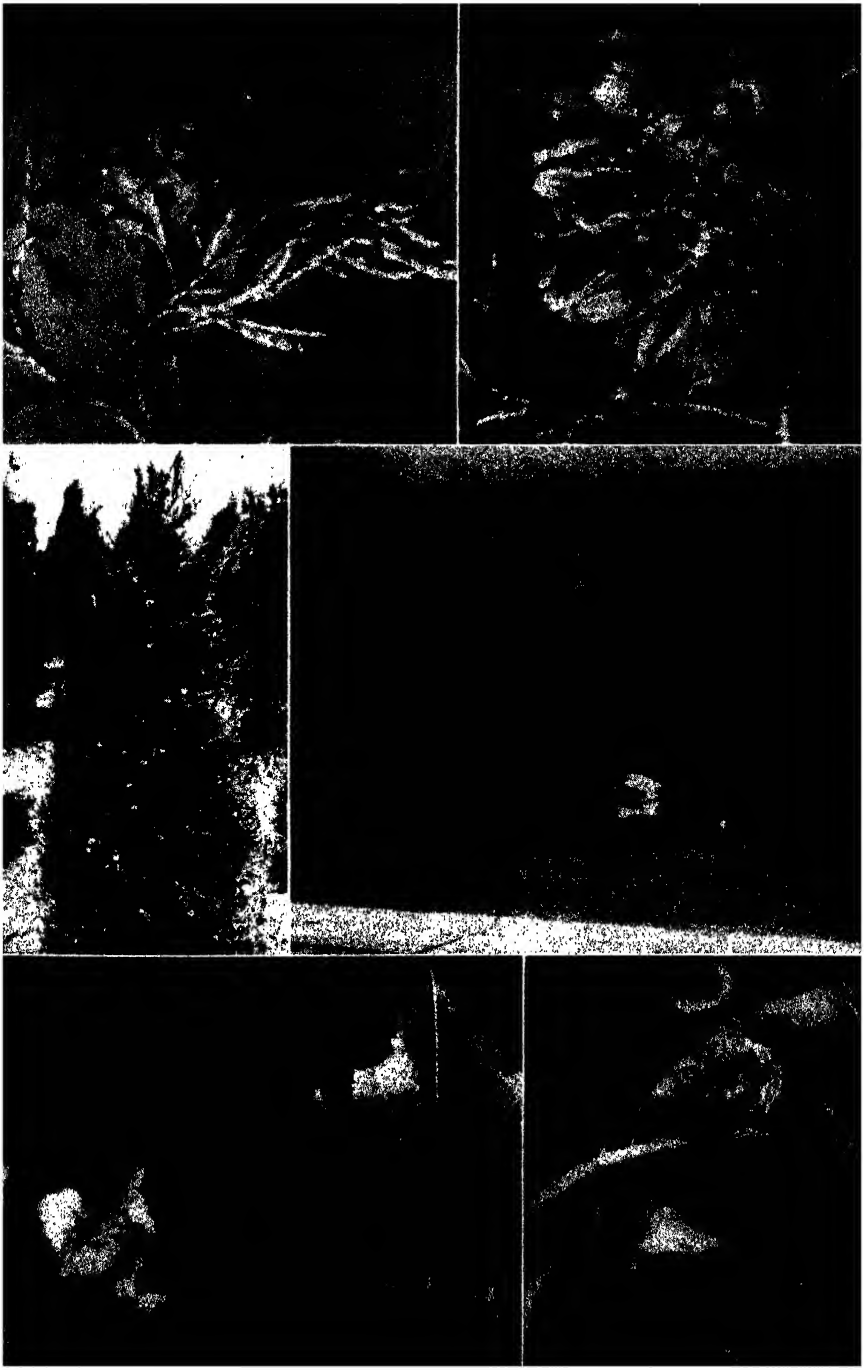
Upper right—Telial horns gelatinized and shedding spores after being wetted by rain. It is too late to spray now, since heavy spore dispersal has already taken place.

Middle left—Red cedar with many large galls of the cedar-apple rust.

Middle right—Typical example of red cedars planted in a memorial site, with native hawthorns in the nearby background.

Bottom left—Cedar-hawthorn rust lesions on hawthorn leaves.

Bottom right—Cedar-apple rust lesions on Bechtel's crab apple leaves and fruit.



and Evergreen Cemetery locations, the alternate host was represented by six native hawthorn trees including both the rough-leaved (very susceptible) and smooth-leaved (moderately susceptible) varieties. Of necessity, the sprayed trees were not adjacent to the untreated control plots but were within 3 miles except in the case of the Ionia location.

The sprays were applied to the cedar trees at the time when spore horns on the galls were about ⅛ to ¼ inch long. Later in the summer leaf counts were made on the pomaceous host to estimate the percentage of infection occurring. The results are recorded in Table 1.

Observations of spray treatments over a period of 5 years with a single application each season of a 1-percent Elgetol solution indicate that considerable temporary injury often occurs to branch terminal foliage of the open needle varieties of red cedar while little or no injury occurs on appressed needle varieties such as *J. virginiana* var. *canaertii* or *J. virginiana* var. *glauca*. Such injury as did occur was always outgrown in 2 or 3 months.

Bordeaux 180 (2), a regular bordeaux mixture to which has been added mono-calcium arsenite and zinc arsenite, was first tested in

TABLE 1—*Reduction of rust incidence on hawthorn and Flowering apple as a result of spraying adjacent Red cedars*

Year	Treatment	Location	Leaves counted	Leaves rusted	Percentage infection
1941	Elgetol 1 percent	Ionia Memorial	741	115	15.5%
	Elgetol 1 percent	Evergreen Cemetery	310	72	23.2
	Untreated	Field 19	396	384	96.9
1942	Elgetol 1 percent	Ionia Memorial	310	51	16.4
	Elgetol 1 percent	Evergreen Cemetery	402	31	7.7
	Untreated	Field 19	450	427	94.8
1943	Elgetol 1 percent	Ionia Memorial	894	155	17.3
	Elgetol 1 percent	Evergreen Cemetery	846	119	14.0
	Untreated	Field 19	621	593	95.4
1944	Elgetol 1 percent	Ionia Memorial	3300	296	8.9
	Elgetol 1 percent	Evergreen Cemetery	960	81	8.4
	Bordeaux 180	N. E. Campus	192	12	6.2
	Bordeaux 180	Mary Mayo Hall	311	11	3.5
	Untreated	Field 19	671	617	92.0
1945	Elgetol 1 percent	Ionia Memorial	829	102	12.3
	Elgetol 1 percent	Evergreen Cemetery	1846	54	2.9
	Bordeaux 180	N. E. Campus	776	21	2.7
	Bordeaux 180	Mary Mayo Hall	649	13	2.0
	Untreated	Field 19	925	919	99.3
1946	Bordeaux 180	Ionia Memorial	884	115	13.0
	Bordeaux 180	Evergreen Cemetery	4256	145	3.4
	Bordeaux 180	Glenmore	216	4	1.8
	Untreated	Field 19	721	692	96.0
1947	Bordeaux 180	Evergreen Cemetery	7403	128	1.7
	Bordeaux 180	Glenmore	1000	0	0
	Untreated	Field 19	500	482	96.4

Connecticut (3) for the control of cedar-apple rust and was found to be effective. This spray has been included in Michigan tests on red cedar galls in the spring. Over a period of 5 years, this treatment has reduced the incidence of rust infection on nearby hawthorn and apple foliage to a remarkable extent, and to date has produced no injury on red cedar foliage.

Some modification has been made in the original formula. Soybean flour has been used to replace fish oil as a sticker since the latter is sometimes difficult to secure and because the fishy odor is considered objectionable. Results of these tests are summarized in Table 1.

SUMMARY OF RESULTS

Applications of 1-percent Elgetol sprays on rusted red cedars resulted in reductions in the amount of infection on adjacent hawthorn leaves ranging from 93 to 73 percent less than that developing on hawthorns near unsprayed cedars. This is considered to be very good control of these rust diseases. However, considerable browning of foliage on branch tips is common and results in an unsightly appearance of sprayed trees. Such trees soon produce new leaves and by midsummer usually recover their normal appearance. Because of this injury, the use of Elgetol as a control fungicide is not recommended.

Applications of bordeaux 180 on rusted red cedars resulted in reductions in the incidence of infection on adjacent hawthorn leaves, ranging from 94 to 83 percent less than that developing on hawthorns near unsprayed cedars. No foliage injury has been observed on any red cedar tree sprayed with this fungicidal mixture throughout the five seasons in which it has been used, and therefore its recommendation is considered safe.

RECOMMENDATIONS

A single application of bordeaux 180 to red cedar trees in the spring when the horns (telia) on the galls are about ⅛ to ¼ inch extended is recommended (Fig. 1, upper left). The spray should be applied if possible just before rains cause the gelatinization and expansion of the horns. Proper timing of the spray applications is important if best results are to be obtained (Fig. 1, upper right). Thorough coverage should be made, using a finely divided spray. Pump

pressures from 150 to 450 pounds have given good results in the experimental tests.

Bordeaux 180 formula:

Copper sulfate	12 pounds
Lime (fresh hydrated)	12 pounds
Mono-calcium arsenite	2 pounds
Zinc arsenite	8 pounds
Soybean flour (sticker)	1 pound
Water	100 gallons

Fractional amounts of this formula may be prepared using the same proportional amounts of the materials. The hydrated lime and the copper sulfate are mixed first according to the regular methods for making bordeaux mixture. Then the arsenites and the soybean flour are added.

It is advisable to contact your spray material supply dealer as early as possible in order to obtain these arsenite compounds which are not regularly sold.

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THE EFFECT OF BUFFERS ON THE GROWTH-INHIBITING PROPERTIES OF SODIUM 2,4-DICHLOROPHENOXYACETATE

By E. H. LUCAS, IRMA M. FELBER, C. L. HAMNER, *and* H. M. SELL
SECTIONS OF HORTICULTURE AND AGRICULTURAL CHEMISTRY

IN TWO earlier reports (1, 2) preliminary account was given of the increased effect of the sodium salt of 2,4-dichlorophenoxyacetic acid (abbreviated "2,4-D" in this paper) when it was applied simultaneously with onion extracts or acids. In these instances the formative effect of nonherbicidal doses and the herbicidal action of higher concentrations or of larger quantities applied were comparable to those of the water-insoluble acid and esters. The advantages of such stimulation are obvious since both acid and esters are more expensive than the salt, inconvenient in handling because of their insolubility in water, and dangerous to plant life because of their volatility.

The role of the enhancing effect of onion extracts was further investigated, but has so far not given any conclusive results. In the course of this study the buffering properties of onion and other plant extracts were considered among possible reasons for their specific performance. This led to an examination of the influence of buffer solutions prepared for various pH levels. The results of this examination are presented in the present publication.

EXPERIMENTAL

As in earlier experiments, certified seed of the Red Kidney bean was used for the production of test plants. The experimental procedure was somewhat altered since it was desired to eliminate certain variations observed in the results of earlier experiments. The seed was weighed or screened to insure uniformity; only medium-sized beans of 0.5-0.6 g. weight were planted. One seed was planted per 4-inch pot. The plants were treated in the general manner described in earlier papers (1, 2); however, since the dropper bulb micro pipettes previously used did not deliver drops of sufficient uniformity, 1 drop

ARTICLE 30-42

(approximately 57 mgm.) was applied to each plant by means of specially selected 1.5 ml. pipettes. A new procedure, proposed in a recent publication (3), was used for the evaluation of the results obtained. Terminal growth, lateral growth, and proliferating tissue were weighed separately and plotted graphically.

On account of higher temperatures, the beans grew more rapidly in the tests described than in earlier experiments. Plants treated at the same stage of development as in experiments previously reported were 6-8 days old as compared with an age of about 10 days, the average in earlier experiments.

The test materials were solutions of the sodium salt of 2,4-dichlorophenoxyacetic acid (obtained as C.P., but recrystallized until constant melting point was attained) at pH 2, pH 3, pH 4, pH 5, pH 6, and pH 7. Each solution was used unbuffered and buffered. The following buffers were prepared: for pH 2, 0.2 N hydrochloric acid and 0.2 N potassium chloride; for pH 3, 0.1 M potassium acid phthalate and 0.1 N hydrochloric acid; for pH 4, pH 5, and pH 6, 0.1 M potassium acid phthalate and 0.1 N sodium hydroxide; for pH 7, 0.1 M monopotassium phosphate and 0.1 N sodium hydroxide. For the adjustment of the unbuffered solutions orthophosphoric acid and sodium hydroxide respectively were used.

DISCUSSION OF RESULTS

It was found that 2,4-D when applied in buffered solutions exerted a far superior inhibiting effect than when dissolved in unbuffered liquids at pH 4, pH 5, pH 6, and pH 7. At pH 2 and pH 3, the acidity of the solution sufficed to increase the growth-inhibiting effect to maximum efficiency (2); whether a solution within this range is buffered is immaterial. At higher pH levels, however, the situation

TABLE 1—*Effect of pH in unbuffered 1,000 p.p.m. solutions of sodium 2,4-dichlorophenoxyacetate upon terminal growth of bean plants*

pH	Terminal growth of 10 plants in grams
2	0.0
3	0.4
4	36.2
5	41.2
6	69 0
7	64.7

TABLE 2—*Effect of pH in buffered 1,000 p.p.m. solutions of sodium 2,4-dichlorophenoxyacetate upon terminal growth of bean plants*

pH	Terminal growth of 10 plants in grams
2	0.0
3	0.2
4	0.6
5	0.0
6	0.8
7	0.0

changes strikingly as Figs. 1-5 demonstrate. Tables 1 and 2, as well as the diagrams (Figs. 6 and 7), support the visual observations.

Tests with 2,4-D in solutions at pH 8 and above showed inconsistent relations between the effect of the buffered and the unbuffered preparations, and are therefore not considered in this report.

In Fig. 1 the growth response of bean plants is illustrated according to ascending pH levels of the applied unbuffered 2,4-D solutions. At pH 2 the injurious effect is lethal; at pH 3 terminal growth is in-

Fig. 1. The effect of pH changes in unbuffered solutions containing 1,000 p.p.m. of sodium 2,4-dichlorophenoxyacetate upon the inhibition of shoot growth of bean plants. Plants from left to right show a gradual decrease of inhibition of growth in accordance with the rising pH values of 2, 3, 4, 5, 6 and 7.

Fig. 2. The effect of pH changes in buffered solutions containing 1,000 p.p.m. of sodium 2,4-dichlorophenoxyacetate upon the inhibition of shoot growth of bean plants. At pH levels, from left to right, of 2, 3, 4, 5, 6 and 7, the treated plants show equal growth inhibitions.

hibited, but weak cotyledonary shoots and lateral shoots from the axils of the primary leaves develop; at pH 4 only one lateral shoot with defective trifoliate leaves is formed; at pH 5 abundant lateral growth is produced, but all the leaves show the characteristic mosaic-like symptoms; at pH 6 the plant looks almost normal, except for the remaining curvature of the first internode, from which adventitious roots arise; at pH 7 terminal growth proceeds, but some of the compound leaves are modified in structure.

The result of treatments with buffered 2,4-D solutions at the same pH levels, as were used in the experimental series of Fig. 1, is shown in Fig. 2. Almost complete inhibition of growth of all plants is evident, regardless of the pH of the solutions applied, ranging from pH 2 to pH 7. The first two plants at the left seem taller, because the original curvature of their first internodes has disappeared. All plants died shortly after the picture was taken.

The difference between effects of buffered and unbuffered 2,4-D solutions at pH 2 are practically none, although the lethal injuries may vary (Fig. 3). In Figs. 4 and 5, however, there are very remarkable differences in growth subsequent to treatments with buffered and unbuffered 2,4-D solutions at pH levels of 5 and 7, respectively.

An explanation for the effect of the buffer solutions cannot be offered at the present time. It is assumed that the buffering action,

rather than a specific constituent of the buffer solution, is responsible. The equally inhibiting effect of 2,4-D in the variety of buffer solutions used seems to indicate this. Although at the low pH levels, no enhancing effect of the buffer solutions was recorded, it must be noted that two different buffers were used, and that the acidity of the solutions already insured a maximum inhibiting effect.

It was considered that the enhancing effect on the action of 2,4-D exerted by onion extracts and by buffers might be possibly correlated on the basis of their buffering properties. The buffer value according to VanSlyke (4) was therefore determined for a representative onion extract and for a buffer solution of the same pH value. It was found that 0.26 ml. of 0.1 N HCl was required to shift the pH of onion extract

Fig. 3. On the left: plant treated with unbuffered 2,4-D solution at pH 2. On the right: plant treated with buffered 2,4-D solution at pH 2.

Fig. 4. On the left: plant treated with unbuffered 2,4-D solution at pH 5. On the right: plant treated with buffered 2,4-D solution at pH 5.

from pH 5.6 to pH 5.1, while 6.9 ml. was necessary to shift the pH of the buffer solution within the same range. The buffer value, or buffer index, is, according to Small (5), a direct definite measure of the buffer capacity. It is calculated as dB/dpH, where dB is the number of gram-equivalents of acid or base required per liter for the observed change of pH in one liter of buffer solution. The formula for the buffer index is therefore: $\frac{\text{conc. of acid x vol. of acid in ml.}}{1000}$, divided by the shift in pH. The buffer value for the onion extract, calculated on the basis

of this formula, was 0.0052; the buffer value for the buffer solution was 0.138. This is valid proof that there is no correlation between the buffering properties of onion extract and its stimulating effect. The pH range of onion extract (between pH 5 and pH 6) also eliminated the possibility that acidity might be the factor responsible for the stimulation obtained. It seems, therefore, that in the cases of onion extract, of acids and of buffers, three different enhancing factors are in operation. These factors may, however, act on one and the same mechanism which would then be directly responsible for the increased effect of 2,4-D.

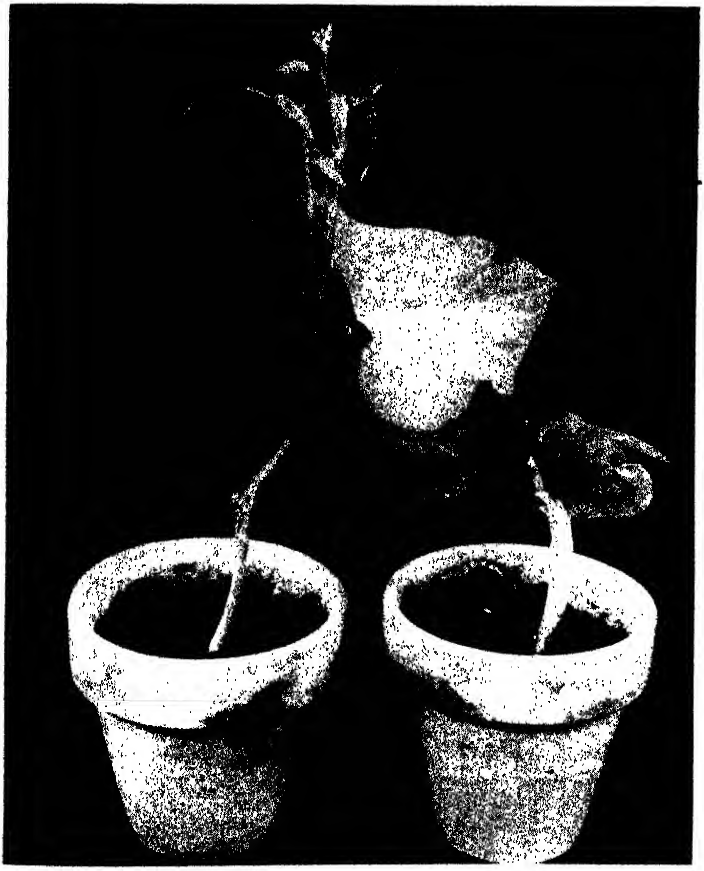

Fig. 5. On the left: plant treated with unbuffered 2,4-D solution at pH 7. On the right: plant treated with buffered 2,4-D solution at pH 7.

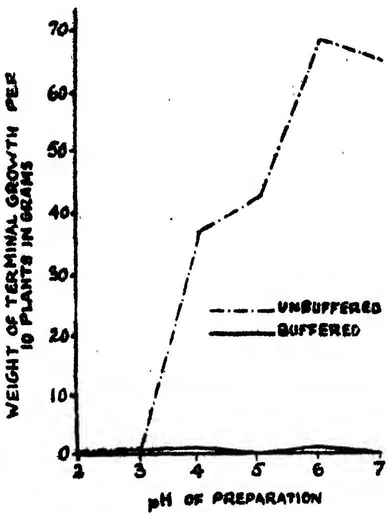

Fig. 6. Terminal growth of bean plants treated with 1,000 p.p.m. of sodium 2,4-dichlorophenoxyacetate at different pH levels.

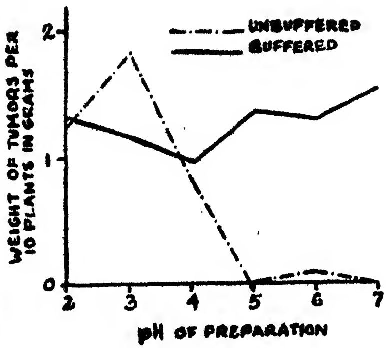

Fig. 7. Proliferation of tissue subsequent to treatment of bean plants with 1,000 p.p.m. of sodium 2,4-dichlorophenoxyacetate at different pH levels.

SUMMARY

The effect of buffers on certain growth-inhibiting properties of sodium 2,4-dichlorophenoxyacetate is reported. At pH 2 and pH 3 buffered and unbuffered solutions of 2,4-D exerted similarly strong inhibiting effects on bean plants. At pH 4, pH 5, pH 6, and pH 7, however, the inhibiting effect of 2,4-D was far greater in buffered than in unbuffered solutions. In the former it equalled the effect obtained at the low pH levels. At pH levels of 8 and above, the relationship between buffered and unbuffered solutions became erratic and requires further investigation.

Neither the buffer system nor the acidity level furnishes an explanation for the increased efficacy of 2,4-D solutions prepared with onion extract. In this case another, as yet unknown, factor must be responsible for the apparently synergistic action.

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INSECTICIDES INCREASE LEGUME SEED

By C. E. PEDERSON[1]
SECTION OF ENTOMOLOGY

LEGUME SEED production has fallen off steadily in Michigan for the last 15 years. During this period more and more experiment station workers, extension specialists, growers, and other interested persons have joined in a search for the factors bringing about this reduction. Considerable attention has been given to varietal differences, cultural practices, soil conditions, pollinization and seed setting, and harvesting practices. While it has long been known that many species of insects are injurious to legumes, some of these affecting seed production directly by their feeding and oviposition, no record has been made in Michigan of what effect the control of these insects will have on seed production. Rather extensive field trials were conducted during 1947 with sprays and dusts of several insecticides as a preliminary study of the problem of pest insect influence on seed production.

METHODS

Field treatments for insect control included both first- and second-stand crops. First-stand fields were treated in Antrim, Alcona and Ingham counties, and second-stand fields were used in Tuscola and Lenawee counties. An attempt was made to use test plots of approximately one acre in size. The actual plots varied from 0.7 to 1.28 acres, the size being determined by field dimensions. They were laid out as parallel strips across the length or breadth of the field. Where possible, as on larger fields, a strip near the center was reserved as an untreated check plot. The plots were generally laid out so that strips of at least an acre remained on either side which also served as check plots. Larger field plots of up to 5 acres were treated in two instances.

[1]Acknowledgment—Appreciation is hereby extended to members of the Department of Farm Crops, who provided general information and suggestions, and especially to Mr. Carl Hanson, Graduate Assistant, for his valuable aid in obtaining some of the seed yields and threshing of the small quadrat samples; to county agricultural agents and growers in the different counties, for their cooperation in locating suitable stands, use of fields and aid in obtaining combine yields; and to the author's colleagues in the Department of Entomology for their aid and suggestions.

ARTICLE 30-43

The dust and spray applications were applied shortly before the plants came into bloom. This is generally referred to as the prebloom or bud stage. A few treatments were applied on new growth of second-stand alfalfa and red clover.

DUST TREATMENTS

Most of the field treatments were applied as dusts. These dusts were pyrophyllite based and included the following formulations: 5-percent DDT, a combination of 2½-percent DDT with 0.25-percent gamma benzene hexachloride (BHC), a 0.36-percent gamma benzene hexachloride (or 3-percent BHC), 3-percent chlordane, and another combination of 3-percent DDT with 2-percent chlordane. The initial stockpile of dust materials supplied all the experiments. Approximately 30 pounds of the dust formulations was applied per acre. Unless noted otherwise, and excepting small errors in application, this was the dosage applied on all the test plots listed in the tables.

All the dusts were applied by an 18-nozzle Niagara field duster which was transported in a jeep-drawn, two-wheeled trailer. The nozzles were equally spaced on a 20-foot boom, with a ground clearance of approximately 16 inches. A canvas apron, which was hung along the length of the boom, covered the nozzle openings and trailed for a distance of 6 feet. This shielded the nozzle openings from air currents. A longer apron would give additional protection from dust drifting, by keeping the newly emitted dust near the ground and, at the same time, giving it a better chance to settle on the plants within the dusted strip. However, dust drift was not of any great significance in any of the trials cited in this paper.

SPRAY TREATMENTS

All the spray treatments referred to in the tables, illustrations and the general discussion were made on fields in Antrim County. They were applied by a tractor-drawn potato sprayer, equipped with a 20-foot spray boom. The 18 wide-angled nozzles were so arranged that the spray hit the plants from above and from the sides. Approximately a hundred gallons of spray was applied per acre. The materials used in spraying were all in a 50-percent wettable powder form and were added in the amounts per hundred gallons of water to give the same dosage per acre of actual insecticidal material as in the dust treatments.

Fig. 1. Bundles of alfalfa stems from untreated check and DDT-treated areas 3 weeks after spraying. While the untreated area had only a few scattered blooms, the treated area showed a profusion of blooming and, on the average, stood 4 to 6 inches taller.

A 20-acre field of very uniform stand alfalfa in Antrim County was used to test the insecticides, both as dusts and as sprays. First, a series of plots was treated with the different dusts. Then, on the other side of a 100-foot-wide median check strip, a series of plots

TABLE 1—*Seed yields on dusted and sprayed plots of first-stand alfalfa in Antrim County. Field No. 1*

Treatment	Yield in pounds per acre*			
	Dusted plots		Sprayed plots	
	From combine samples	From quadrat samples	From combine samples	From quadrat samples
Untreated checks	27	128	41	107
Benzene hexachloride	41	272	97	262
DDT with benzene hexachloride	62	194	99	248
DDT (30 lb. dust, 1½ lb. actual DDT per acre)	71	245	100	263
DDT (45 lb. dust, 2¼ lb. actual DDT per acre)	79	249	122	307
Chlordane	62	232	65	187
DDT with chlordane	67	176	74	251
Untreated checks	28	89	28	89

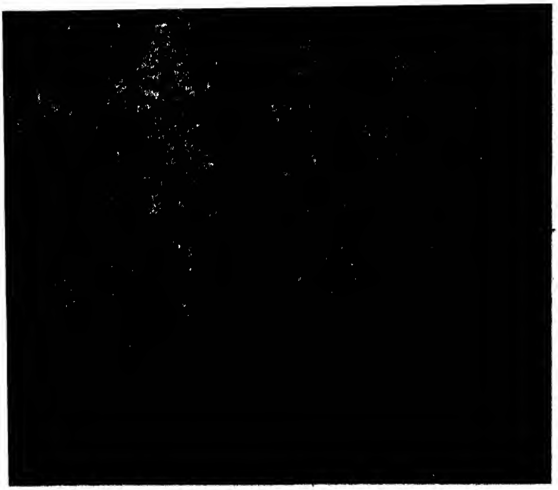
*The quadrat samples were cut 13 days prior to combining. Heavy rains fell during this period and caused a big reduction in seed yield.

was treated with sprays which duplicated the dust dosages. Results of this set of trials are given in Table 1.

Samplings of the insects present in the field plots were made by net sweepings both before and after treatments. These gave a good indication of what insects were present, their actual numbers, and also how they were affected by the insecticides. The findings of these samplings will not be discussed in this report.

YIELD SAMPLING

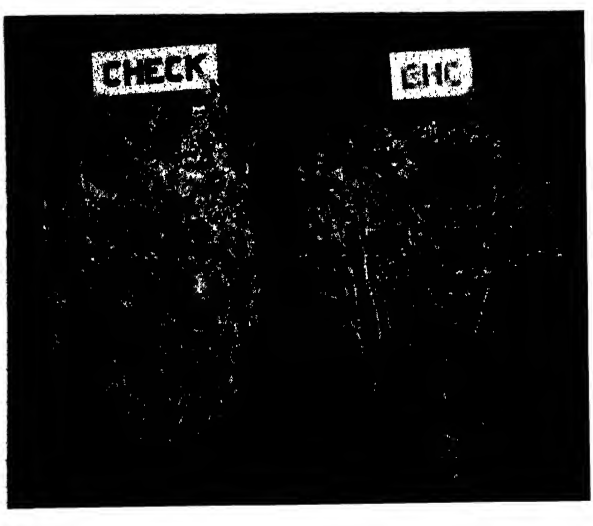
To establish the resultant yields, two methods of sampling were used on most of the trial fields. Large-scale field yields were obtained by combine samples at harvest time. The methods by which these were sampled varied. Some of the yields were obtained by combining a measured length of windrow, the width represented by the windrow also being known. In others the entire plot was combined separately with the combine cuts made in only one direction. The combine yields given in the tables are weights of clean seed per acre. A second type of yield sampling was made by cutting one square yard quadrats in five representative locations in each treated plot and each check area before the fields were harvested. These samples were placed in cloth sacks and hung up to dry. Later they were threshed and the seed cleaned and weighed. The yield per acre was computed on the basis of the weight of clean seed obtained from the 5 square yards sampled.



A. (above) Untreated check and DDT-treated bundles.

Fig. 2. Representative bundles of treated and untreated alfalfa cut when the treated plants were well matured. The untreated plants still bore considerable green foliage and only about one-fourth of their seed pods showed any degree of ripening.

B. (below) Same untreated check with bundle from plot treated with benzene hexachloride.



WEATHER INFLUENCES

In all of the counties where trials were made, with the exception of a few of the test plots in Alcona County, heavy and intermittent rains, immediately preceding and during the normal harvesting period, reduced yields considerably by causing shattering of seeds from erupting pods. These rains also caused lodging and brought on new vegetative growth which smothered the ripening seed stand before harvesting could be completed. Nearly all the quadrat samples were cut before these rains set in. Therefore, the results shown in pounds per acre for the two methods of sampling on any one plot are not necessarily comparable, except possibly for the effect of this rainy period on seed reduction. However, when one compares the effectiveness of different materials on the same series of plots, the relative yield increases or decreases should be expected to be about the same for the two methods of sampling. There is one definite exception to the foregoing statement. It should be noted that the seed pods in many of the treated plots were much advanced in ripeness as compared with those in their respective check plots. This unquestionably led to the shattering out of a greater percentage of seeds in some of the treated plots.

RESULTS AND DISCUSSION

The results of the spraying and dusting trials are given in the tables 1-5. The order in which the treatments are listed is the same as that of the plots in the field. The fields on which the first stand was left for seed produced the highest yields as well as some of the most striking yield differences. The second-stand seed crops did not produce very well. The seed set was poor-to-average, and much of it shattered out during the September rains. A third stand of heavy vegetative growth made harvesting of second-stand alfalfa very difficult.

All first-stand alfalfa treatments were made in Antrim and Alcona counties. The fields treated in Antrim County produced the greatest yield increases. On one field three treated plots produced from

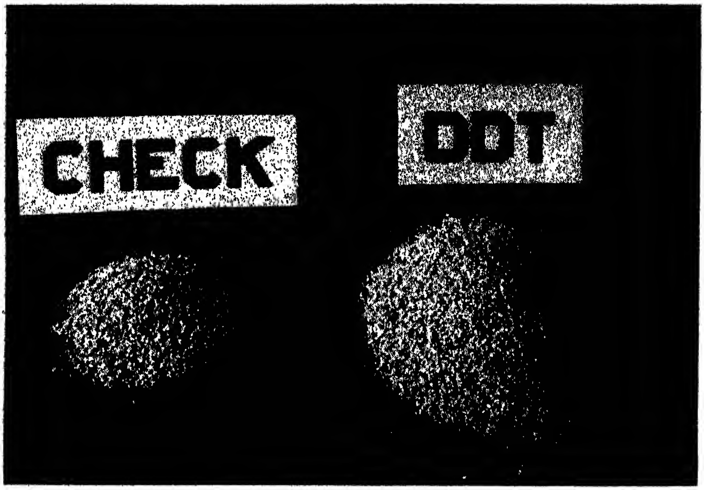


Fig. 3. The yield from 5 square yard quadrats from untreated check and DDT-dusted alfalfa.

eight to ten times as much seed per acre as the check area (see Table 2). Table 1 shows the results from another field where all the dust formulations were tested, and, in addition, these treatments were also duplicated as sprays. It will be noted that treated plots yielded from two to three times as much seed as the untreated check areas. A somewhat higher yield in the sprayed plots might lead one to conclude that spraying is more effective than dusting. However, there

TABLE 2—*Seed yields on sprayed plots of first-stand alfalfa in Antrim County. Field No. 2*

Treatment	Yield in pounds per acre: Combine samples*	Yield in pounds per acre: Quadrat samples
Untreated check	....	29
DDT	94	242
Benzene hexachloride	203	231
DDT with benzene hexachloride (dosage—double strength)		285

*The benzene hexachloride and DDT with benzene hexachloride plots were combined as one plot. The DDT plot was combined two weeks later following intermittent rains. The grower did not consider the check area worth harvesting.

TABLE 3—*Seed yields on dusted plots of first-stand alfalfa in Alcona County*

Treatment	Yield in pounds per acre*			
	Field No. 1		Field No. 2	
	Combine samples	Quadrat samples	Combine samples	Quadrat samples
Untreated check	....	....	154	350
DDT, 30 lb. per acre	29**	320	197	533
DDT, 60 lb. per acre	107**	332	....	....
DDT with chlordane	145	308	....	....
Untreated check	69	189	....	....
DDT with benzene hexachloride	130	296	169	252
Benzene hexachloride	155	319	....	....
Untreated check	....	....	207	....

*There was a two weeks interim with intermittent rains between the dates of quadrat sampling and combining. Field No. 2 laid in swaths during this period.

**Difficulties with combine adjustments and poorly dried swaths undoubtedly accounted for the discrepancy in the yields of the DDT plots in Field No. 1.

are many factors to be considered. For example, the rather dry conditions of the vegetation the morning that the dusts were applied did not promote a good sticking surface for dust particles and much of the material was lost to the ground.

The alfalfa yields in Alcona County are represented in Table 3. A third field is omitted because of rather unreliable samplings of yield. No quadrat yields were obtained. The combine yields showed from 4 to 5 bushels of clean seed per acre on all the plots, with the untreated check as good or better than the treated plots.

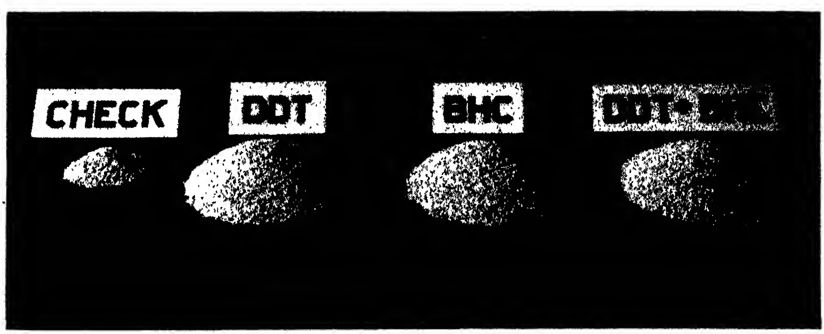


Fig. 4. The yield of alfalfa seed from 5 square yards of representative area in untreated check and plots treated with DDT, benzene hexachloride, and DDT with benzene hexachloride, respectively. (The samples are from the same field as that represented in Fig. 2.)

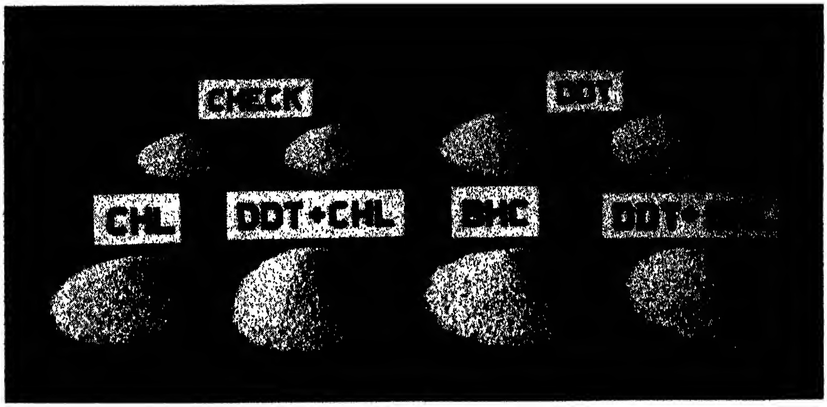


Fig. 5. The yield of alfalfa seed from 5 square yards of representative area in eight test plots. (See Table 1, sprayed plots, quadrat samples, for the calculated yield per acre of the samples shown.)

The results of dust trials on second-stand alfalfa are shown in Table 4 and part of Table 5. The first stand on these fields was cut for hay around July 1. Although both of these fields appeared fairly uniform in midseason, the yields from the untreated checks, as well as from the other plots, show that there was great variation from one side to the other. In the Lenawee field, bacterial wilt was prevalent among the plants in untreated check No. 2 and the three neighboring plots. The yield result on the plot which received two applications of DDT dust is questioned. Quadrat samples from this field are being processed at the time of writing and it is believed that these will show just as high a yield on this plot as on the neighboring plot which received the early DDT treatment.

TABLE 4—*Seed yields on dusted plots of second-stand alfalfa in Tuscola County*

Treatment	Yield in pounds per acre	
	From combine samples	From quadrat samples
Untreated check No. 1	33	36
Benzene hexachloride	47	50
Untreated check No. 2	42	63
Chlordane	57	74
DDT, 25 lb. per acre	69	124
DDT, 30 lb. per acre	73	....
DDT with chlordane	82	145
DDT with benzene hexachloride	77	149
Untreated check No. 3	70	117

TABLE 5—*Seed yields on dusted plots of second-stands of common red clover and alfalfa in Lenawee County*

Treatment	Combine yield in pounds per acre	
	Clover	Alfalfa
Untreated check No. 1	31	49
DDT, applied immediately after first cutting was removed	46	72
DDT, two applications, one immediately after first cutting and one in prebloom stage	55	55
DDT, in prebloom stage	37	58
DDT with benzene hexachloride	36	46
Benzene hexachloride	....	28
DDT with chlordane	....	25
Untreated check No. 2	30	11

A mammoth clover field in Ingham County was dusted in late June. Drouth and other factors led to a relatively poor yield. Certain areas of the field were so poor that they were cut out in harvesting and, as a result, a satisfactory check was not obtained from the combine samples. However, the quadrat samples taken on this field showed the following yields per acre for the treatments indicated: 34 pounds on untreated checks, 98 pounds on DDT with chlordane, 72 pounds on DDT (50 pounds of dust per acre), 40 pounds on DDT (20 pounds of dust per acre), 55 pounds on DDT with benzene hexachloride, and 35 pounds on benzene hexachloride.

The red clover trials, listed in Table 5, indicate that the early dusting was the most effective application. This is a factor which requires further testing. It is quite likely that both first- and second-stand seed crops would benefit by an early treatment, that is, an insecticide application while the new growth is less than 6 inches in height. Stunting due to insect injuries may be greater at this stage of growth than is generally recognized.

Observations made during the course of the dusting and spraying trials indicate that the use of some of these materials also increased the hay yield. However, residues of these poisons are known to remain on the plants for a long time. Because of this residue problem, none of the materials listed in this paper can be considered safe to use on vegetation which will be fed to livestock. Therefore the use of any one of these on forage stands should be discouraged until the safety factors are determined. The same precautions should be observed when contemplating feeding of straw from treated fields or grazing animals on these fields.

SUMMARY AND CONCLUSIONS

1. Formulations of DDT, benzene hexachloride and chlordane were tested against pest insects on alfalfa and clover grown for seed. All of these, alone or in combination, promoted yield increases.

2. DDT was as good or better than the other formulations in most of the trials. It was generally applied at the rate of 1.5 pounds of actual DDT per acre, but two or three applications of larger dosages gave slightly added increases in yield.

3. Benzene hexachloride gave results which show that it was almost as effective as DDT. A combination of this material with DDT may prove very effective as a "shotgun" treatment against insects which reduce legume seed production. A pound of 12-percent gamma benzene hexachloride, or 2 pounds of 6-percent gamma BHC, per acre gave good control of certain insects that were only moderately affected by DDT.

4. Chlordane did not give as good results as the other materials, although a combination of this material with DDT showed promise.

5. The suggested time for dusting or spraying alfalfa is the prebloom, or bud, stage of development. No applications should be made while the plants are in bloom because of the toxicity of these materials to pollinating insects. There are some indications that earlier treatments may be very important. In fact, the presence of large numbers of one or more pest insects on young growth can be expected to cause some degree of injury. Eliminating these will remove one retarding factor affecting the growth of the plant.

6. Vegetative materials treated with the insecticides cited are not considered safe for use as forage. Feeding of treated hay or straw, or grazing livestock on treated fields, should be avoided. There is evidence of increases in forage yields with the use of these materials, but as long as they are not considered safe, none of these insecticides is recommended for this purpose.

THE CHEMICAL CONTROL OF GRAIN WINDBREAK ROWS IN MUCK CROPS

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THE CONTROL of interplanted windbreak rows of grain in muck crops can be effectively accomplished by spraying. This method of control eliminates an objection to a very desirable practice to minimize wind damage.

Wind damage during the early stages of growth is one of the greatest hazards in the production of onions and other row crops on muck land. It is necessary to supplement the large windbreak hedges of willow or other woody plants with rows of wheat or barley which are seeded between the rows. The erect and rapid-growing grain reduces the blowing of muck and often saves the young crop from destruction.

The chief objection to interplanting rows of grain between onions or other row crops is the difficulty and cost of removal, particularly in wet seasons. The wheel hoe has been the most common implement employed, and much hand labor is required. Because of the customary close planting of onions, power cultivating equipment has not proved very useful in cutting cut grain, particularly if excessive moisture causes a delay in operations and the grain gets too large. Owing to the removal problem, grain is usually planted at intervals of several rows, frequently one in four. Growers thus compromise between maximum wind protection and economy in grain removal.

In 1946 Dr. Robert Lucas of the William Gehring Farms, Rensselaer, Indiana, became interested in the possibilities of killing or reducing the growth of grain with a chemical spray applied under a hood to prevent spray mist from reaching the onions. His early attempts at accomplishing this end were only partially successful owing to the limitations of the hoods employed. In 1947 hoods originally designed by the senior author for experiments on the chemical

ARTICLE 30-44

cross-blocking of sugar beets proved more successful. At low pressure, i.e. 30 to 40 pounds per square inch, the spray was entirely confined within the hood as it traveled down the row of grain between the rows of onions. Although this method of killing or reducing the growth of protective grain should still be considered in the developmental stage, the hoods employed are described here for the benefit of those who may be interested in experimenting with them. They may possibly find application in other spraying problems where a herbicidal spray must be confined.

EXPERIMENTAL APPARATUS

The success of this method of eliminating windbreak rows of grain depends largely upon the design of the hoods or shields which confine the spray. Their design must permit them to follow the irregular contours which might occur in the soil and allow sufficient space for the pressure of the spray to expand itself. Each hood had three sections which were hinged together by small bolts (Fig. 2). The leading end of the hood was enclosed by a canvas skirt which allowed the

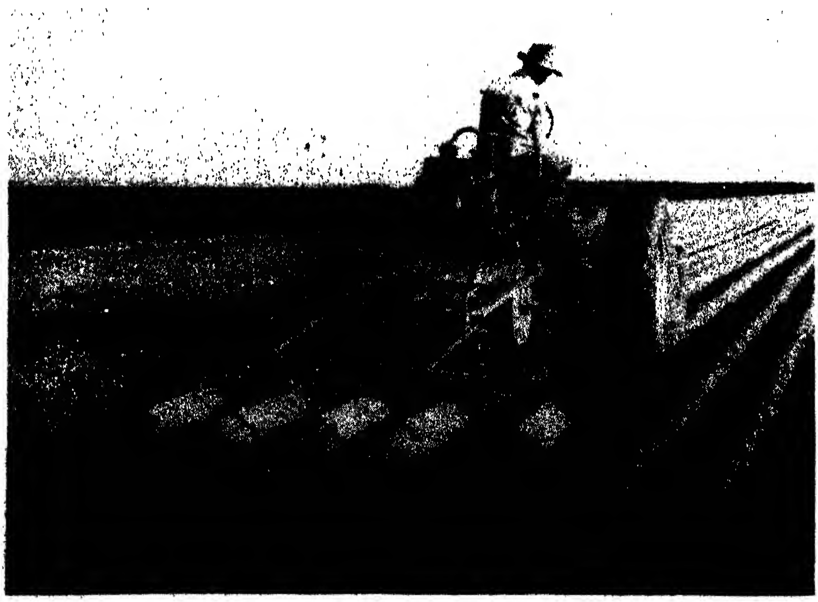

Fig. 1. Unit used in 1947 applying contact spray to rows of grain between rows of onions.

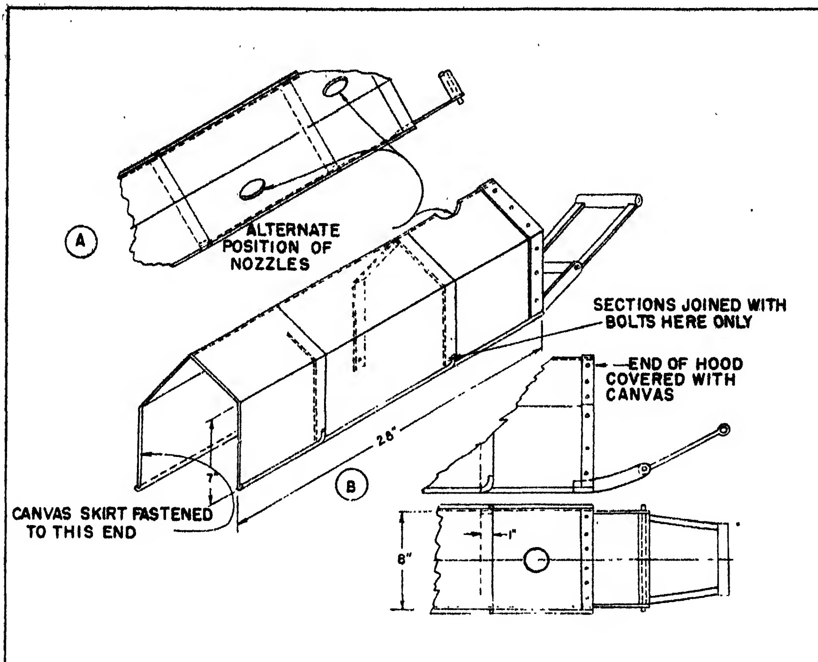

Fig. 2. A detail drawing of the hoods used in the tests. Top view (A) shows an alternate nozzle arrangement.

grain to be sprayed under the hood in an erect position. A canvas skirt was also attached to the trailing end of the hood.

A single bar attached to a rigid frame behind the tractor trailed the hoods over rows of grain (Fig. 1). The controls for the spray and for raising the hoods were readily accessible from the tractor seat. A hinged mounting on the tractor drawbar carried the front of the apparatus while the rear was transported on a single caster wheel. This experimental model used an engine-driven rotary (empellor) pump.

RELATION BETWEEN SPRAY NOZZLES AND RATE OF TRAVEL

One nozzle under each hood will apply suitable quantities of liquid when the grain growth is not profuse (B Fig. 2). Limited tests proved

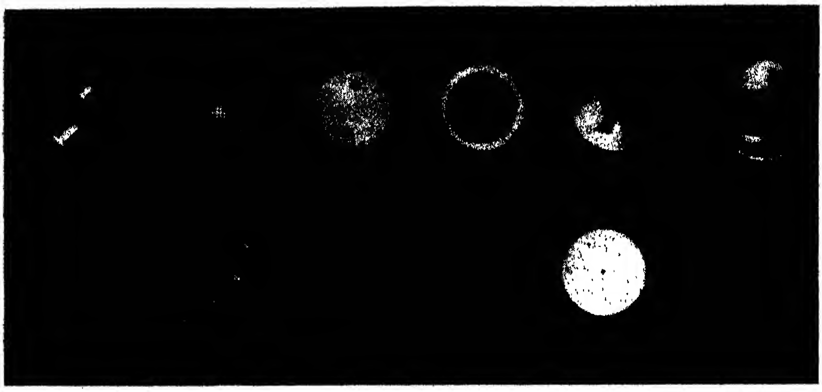

Fig. 3. Integral parts of the spray nozzle used showing assembled nozzle and the alternate cone-spray disk.

that for tall or dense growth the performance was greatly improved when two nozzles were placed at right angles (A Fig. 2). A more uniform wetting of the grain can be secured with the latter type of installation.

The fan-type nozzles functioned satisfactorily throughout the testing program; however, the standard cone-type should operate successfully under many conditions (Fig. 3). The criterion for determining the proper number and type of nozzle is in the results obtained A sufficient "burn" must be obtained with a minimum of spray material. Orifice size 0.059 inch under a pressure of 35 pounds per square inch proved to be adequate and when two nozzles per hood were used, a 0.039-inch orifice size seems to be satisfactory for the chemical employed in the tests.

The speed which the unit traveled down the row was maintained at about 3.5 miles per hour. This speed was necessary to secure the required liquid coverage. The pressure, orifice size and the rate of travel must be synchronized for a given chemical to obtain proper distribution. An increase in speed would require a larger nozzle orifice for a liquid of equal viscosity. The pressure should not be increased above 40 pounds per square inch as this would tend to force the spray beyond the bounds of the hood.

PROCEDURE

Chemicals Employed

The chemical employed in these tests was Dow Contact Weed-killer, a proprietary formulation, the active ingredient of which is dinitro-o-secondarybutyl phenol. A spray consisting of 3 gallons of this formulation made up to 100 gallons with water and applied at the rate of 50 gallons per acre "burned" 8-inch grain to the crowns. The fact that the grain was not completely killed and new growth shortly appeared was considered an advantage because the crowns remained erect and provided further wind protection without the grain becoming too large to cope with. A second spray application a week or more after the first may be desirable under many circumstances; however, grain that has been allowed to re-grow for a few days after one application is easily removed by mechanical tillage equipment, because of the great reduction in volume of leafy material. Furthermore, roots rapidly decay after top growth is reduced by spraying.

The addition of extra oil to phenolic contact sprays improves the penetration of the toxicant to the growing point of the grain and a greater degree of kill can be obtained. In the 1947 tests, grain kill was improved by mixing 3 gallons of Dow Contact Weedkiller with 7 gallons of diesel oil and making up to 100 gallons. On the market now are phenolic contact-type weed killers of a concentrated form to which varying amounts of oil may be added according to the type of vegetation to be controlled, i.e. Sinox General and Dow General. If these formulations are utilized 3 pints of concentrate per 100 gallons of spray are suggested. The amount of oil with which the 3 pints of concentrate should first be mixed can vary from as little as 3 gallons if one only wishes to burn the grain back to the crown and allow regrowth for further protection to as much as 20 gallons if maximum kill is desired. Regardless of the spray mixture used, one cannot expect a complete kill if the grain has been allowed to get quite large before treatment (Fig. 4). From the practical viewpoint it would seem unnecessary to kill completely all grain inasmuch as subsequent cultivation will remove it without the difficulty encountered with unsprayed grain.

Fifty gallons of spray per acre should be sufficient for most in-

Fig. 4. Five rows of grain three days after spraying. Onions between rows of grain were uninjured. Grain in background was not sprayed.

stances in which grain is planted between each row of onions as it was in the above tests. If fewer rows are planted less spray would be required. The volume might be reduced where the grain was rather thin and especially heavy growth may require a greater volume.

OTHER USES FOR HOODS

Crops other than onions growing on muck or sandy soil have sometimes been interplanted with grain and the methods described above might prove worthwhile. In addition, other uses for such a hood might involve the application of a contact weed spray between rows in home gardens and between rows and beds in nurseries. Weeds such as purslane which are very difficult to kill by cultivation during moist weather can be killed with contact sprays.

A MORE PRACTICAL MACHINE

The chief difficulty with the experimental model was that it could not be manipulated easily on the turns. Therefore, a more functional machine might be built, placing the hoods between the front and rear wheels of a small tractor (Fig. 5). A rotary pump driven by the power

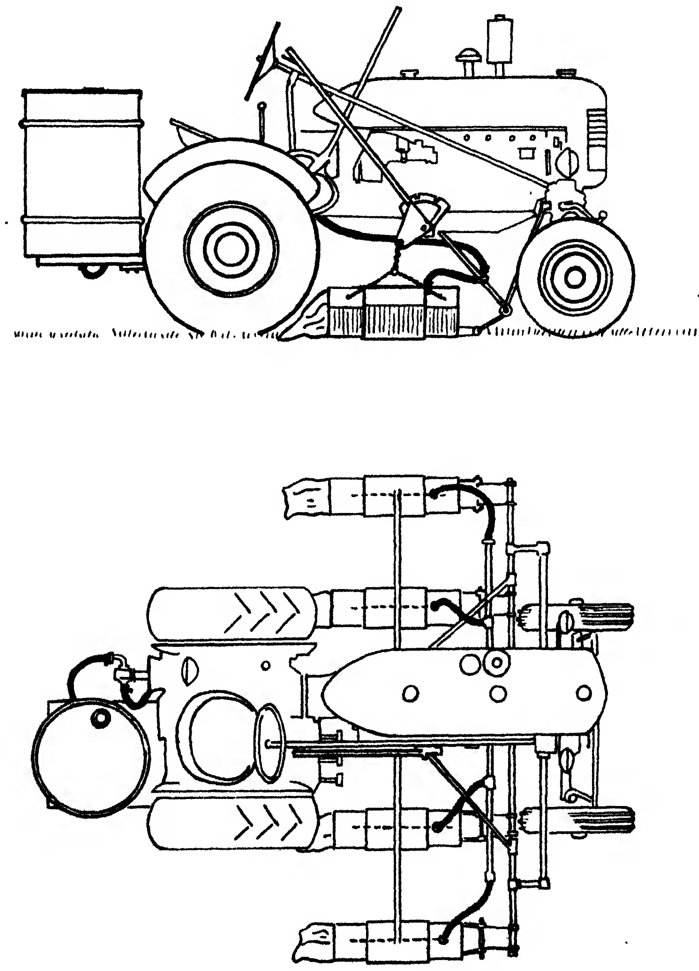

Fig. 5. A machine for chemically controlling windbreak rows in muck crops. This machine has greater maneuverability than the experimental unit.

take-off would eliminate the need for an extra engine. A 50-gallon supply tank, making use of jet agitation, would be ample for many operations. It is suggested that the raising of the hoods might be facilitated by the power lift, or attached to the tractor's integral plow or cultivator levers.

DISCUSSION

One of the advantages of chemical control of grain, planted for wind protective purposes, is the fact that the soil need not be disturbed until the crop is well established. Loose soil is more subject to blowing and if grain is planted between each row the first cultivation can be considerably delayed. Small annual weeds wet by the spray are killed. Even the dead roots and leaves of treated grain offer some protection against blowing. An added advantage is that a delay in the first cultivation means that fewer weed seeds will be brought near the surface where germination can take place. Chemical treatment of grain interplanted between each row will often reduce the total number of cultivations required. The greater wind protection afforded by more rows of grain than now employed might reduce the need for permanent windbreaks that occupy considerable land.

TAX VARIATION IN OAKLAND COUNTY AND TREND TOWARD EQUALIZATION OF TAXES BY MEANS OF ENLARGED SCHOOL DISTRICTS

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MANY PROPERTY owners seem to have a struggle, real or imaginary, to pay their taxes. To comprehend what their tax dollars purchase for many of them is an even greater struggle. The tax picture is complicated in areas of small taxing units. It tends to be even more complicated in localities of rapid population increase and ultra-rapid development of residential subdivisions, like Oakland County, much of which lies in the Detroit Metropolitan District and is in and near the so-called suburban fringe. One of the more significant aspects of the tax structure in such areas is the wide variation in size of the tax dollar, even within the same township, and within the same community. Of even greater significance is the trend toward equalization of taxes through the combination of small taxing units, which usually are school districts.

An understanding of tax variation and of possible tax equalization necessitates a knowledge of school district organization and of possible reorganization. Oakland County serves as a satisfactory unit for a study of property tax intricacies and of equalization trends, and tax and school conditions in this county are similar to those in many other counties of the state.

Oakland County lies partially adjacent to Detroit. It is composed of 25 townships, as indicated in Fig. 1 which also gives the average value of farm land and buildings per acre in 1945. According to the United States Bureau of the Census, the average value of farm land and buildings per acre in that county increased from $97 in 1940 to $133 in 1945. The average per acre in 1945 varied from $47 in Addison Township to $476 in Southfield Township. These figures are based

ARTICLE 30-45

$67 Holly	$78 Groveland	$85 Brandon	$74 Oxford	$47 Addison
$83 Rose	$88 Springfield	$124 Independence	$126 Orion	$75 Oakland
$93 Highland	$77 White Lake	$412 Waterford	$170 Pontiac	$233 Avon
$107 Milford	$151 Commerce	$184 West Bloomfield	$163 Bloomfield	$262 Troy
$121 Lyon	$148 Novi	$204 Farmington	$476 Southfield	$328 Royal Oak

Fig. 1. Average value of farm land and buildings, per acre, by townships, 1945. (Source: United States Bureau of the Census)

on market value as given by farm owners to census enumerators. Normally, tax assessors are guided by market values in determining assessments for property tax purposes. In a majority of the townships of Oakland County, the market value may have been greatly influenced by recent population increases. A special county census taken on January 28, 1947, indicates that the increase in the population between April 1, 1940, and the 1947 census date was 32.4 percent. The population growth was more than twice as great in the open-country as in the incorporated cities and villages, being 50 percent as compared with 22 percent. Among the townships with the greatest population increases during the past 5 years were Troy, Waterford, and Southfield, three out of the four townships with the highest average farm land values per acre in 1945.

Rapid population increases in small taxing units tend to boost taxes because of the need for larger school plants and more equipment, more teachers, more fire-fighting equipment, better roads, more drains, and more of all kinds of governmental services. Farmers are among the first to feel the increasing tax load, and if farm taxes rise much more rapidly than the earning capacity of these farms, some may become tax delinquent. This possibility is accentuated when the need for more parks and recreational areas takes land off the tax rolls, thus throwing additional tax loads upon the remaining farmers and property owners. All possible precautions should be taken to keep tax delinquency down. Farm land in the suburban fringe[1] tends to be uncertain and unstable so far as land use is concerned and quite vulnerable to tax delinquency. For purposes of tax analysis, it is desirable to study at least one township in considerable detail first.

TAXES AND SCHOOL DISTRICTS OF OAKLAND TOWNSHIP

Townships in Michigan are civil administrative units, each with a set of officials—supervisor, clerk, treasurer, and justices. Townships are also taxing and tax-collecting units. Of the 25 townships in Oakland County, one has the same name as that of the county and lies northeast of Pontiac, the county seat, at a distance of 2 to 14 miles. Its average value of farm land and buildings per acre was $75 in 1945, the fourth lowest among the 25 townships.

A perusal of the tax rolls of Oakland Township for 1945 shows a total of 133 pieces of property of 80 acres or more, corresponding approximately to the 124 farms recorded by the United States Census for the same year. Three of these acreages are virtually country estates and are not typical farms. They are excluded from tabulations made of the other 130 farms and listed on the tax roll as "acreages" which average 91 acres in size. Their average assessment for tax purposes was $42 per acre. The average 80-acre farm was assessed at $3,360, and the average 91-acre farm at $3,822. The average property tax per acre was 69 cents.

The property tax on the average 80-acre farm in Oakland Township in 1945 was $55.40, distributed as follows:

[1]Several studies indicate some of the problems of the "fringe" areas in Michigan, namely: "Social Aspects of Land Use Planning in the Country-Fringe: The Case of Flint, Michigan," by Walter Firey, Michigan Agricultural Experiment Station Special Bulletin 339 (1946); and "Michigan's Country-City Fringe," by C. P. Loomis, J. A. Beegle and W. Firey, *Michigan Farm Economics* (June 1946), Michigan State College Extension Service, p. 1.

$12.05	or	21.8	percent for county services
1.76	or	3.2	percent for county debt services
7.20	or	13.0	percent for township services
28.55	or	51.5	percent for school operation
5.60	or	10.1	percent for school debt services
.24	or	0.4	percent for Krohn drain
$55.40		100.0	

Some 80-acre farms in Oakland Township were assessed for less than $1,800, while others were assessed for more than $5,000. The assessed valuation of the average 95-acre farm in Oakland Township, a farm slightly larger than the average farm in this township, is $4,000. This is a convenient figure to use in this analysis of tax variation. The property tax on farm assessments of $4,000 was $65.43, distributed as follows:

$14.32	for county services
2.08	for county debt services
8.48	for township services
33.66	for school operation
6.60	for school debt services
.29	for Krohn drain

All farms in Oakland Township with the same assessed valuation paid the same number of tax dollars for the support of the county government and for the support of the township government. However, the amount paid for school operation and for school debt service was not uniform throughout Oakland Township because that township is not a single school district. In fact, the 36 square miles of Oakland Township is in 12 different school districts, each, like Oakland Township, with taxing and debt-incurring powers.

TAX VARIATION WITHIN OAKLAND TOWNSHIP

Figure 2 is a diagram of Oakland Township, showing boundaries of school districts. Within each school district the tax levy for various purposes, as well as total property tax, is listed on farm assessments of $4,000 for the year 1945. The taxes for county purposes, county debt service, and for township purposes were the same in all of its school districts, namely, $14.32, $2.08, and $8.48, respectively. The tax for school operation varied from $23.84 in three different school districts, (Eaton, Snell and Clifton) to $48.68 in No. 2, in the Bald-

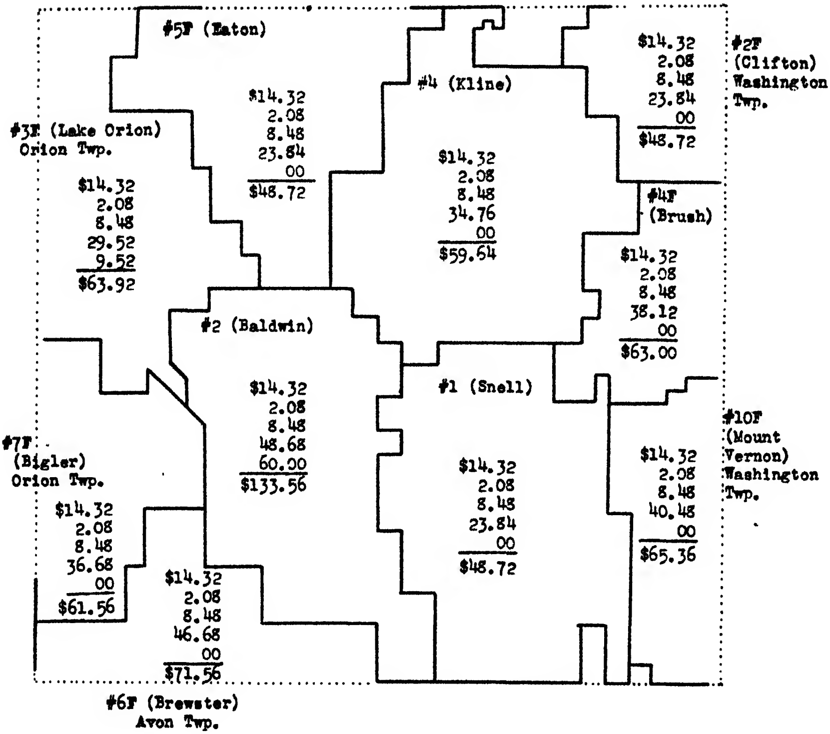


Fig. 2. Oakland Township of Oakland County showing school districts and tax levies on farm property assessments of $4,000 in 1945.

win School District.[1] Two school districts levied taxes for school debt service, in one of which it exceeded that for school operation. The total tax for all purposes on $4,000 assessments varied from $48.72 in three different school districts to $133.56 in No. 2. It is possible that the difference between $48.72 and $133.56, or $84.84, was not directly commensurate with the difference in the quantity and quality of services rendered in the different taxing units. A correct guess might be that some farmers and other property owners are carrying less than their reasonable share of the legitimate tax load, while others are carrying more than should be necessary. A combination of all the taxing units in Oakland Township would equalize the tax load. Some

[1]Two small parcels of land in Oakland Township are excluded from this analysis, namely, 100 acres in sections 35 and 36, which lie in Stony Creek School District of Avon Township, and 240 acres in sections 2 and 3, which lie in Brewer School District of Addison Township.

farmers in sections 2, 3 and 4, whose farms lie in school districts No. 4 and 5F (F indicates fractional school district, that is, lying in two or more townships) paid additional taxes in 1945 for benefits derived from the Krohn drain.

The proportion of the tax dollar going for school operation, excluding the two districts that had levies for school debt service, varied from 49 to 65 percent. The proportion of the total tax dollar going for all school purposes, including debt service, varied from 49 percent in three school districts, to 82 percent in No. 2.

If Oakland Township were one school district, the tax levy in 1945 on an assessment of $4,000, would probably have been about $65, of which approximately $34 would have gone for school operation and $6 or $7 for school debt service. However, from the viewpoint of school organization, a single school district in this township would be unsatisfactory sociologically because part of the township lies in Rochester community, a part in Lake Orion community, and a part in the Romeo community of Macomb County.

Upon completion of the eighth grade, pupils in the Eaton and Bigler School districts commonly attend the high school at Lake Orion, while those in the Brush and Clifton districts generally attend Romeo High School, and those in the other school districts of Oakland Township attend Rochester High School. For purposes of equalization of taxes and educational opportunities, high school attendance areas which possess adequate valuations and high school enrollments, merit serious considerations as taxing units. Unquestionably Rochester and Romeo high school attendance areas meet the qualifications for community school districts as stated by the Michigan Public Education Study Commission in 1943. These qualifications include, among others, that community school districts generally have at least three million dollars of state-equalized real and personal property valuations and be capable of serving adequately a minimum enrollment of 360 students from the seventh through the twelfth grades.

It will be noted from Fig. 2 that the school tax, including school debt service, is over four times as much, and the total property tax is over two and one-half times as much, in School District No. 2 as in the Snell, Eaton, and Clifton districts, with the same assessed valuations. Space limitations do not permit a similar detailed descriptive analysis of the variation in school taxes and total taxes as given in the 1945 assessment rolls in each of the 24 other townships of Oakland County.

RANGE IN TAXES IN SELECTED TOWNSHIPS

A brief discussion seems desirable of the fact that some farmers pay low taxes and others pay high taxes on property of the same assessed valuation within the same township. Table 1 lists 16 of the other 24 townships in which little or no effort had been made previous to 1945 in combining taxing units. This table shows the range in taxes for schools, including debt services, and in total property tax per $4,000 assessed valuation in 1945. Each of these townships still had five or more school districts lying wholly or largely within its borders.

There was no tax levy for school purposes in one district of Addison Township. Here the school electors apparently decided that their school balance from the previous year plus state aid based on the school census were sufficient to defray the cost of education for their few children, provided they closed their school and purchased education for them in another district.

The variation in taxes for school purposes was particularly great among some taxing units in Avon, Independence, Troy, and West Bloomfield townships. Total taxes in certain school districts of Avon, Southfield and Troy townships were higher than in the costliest tax district of Oakland Township.

A comparison of the foregoing figures in one township with those of any other would not necessarily be strictly comparable because of the difference in the assessment ratios to true values. Township super-

TABLE 1—*Range in school tax, including debt service, and in total property tax, per $4,000 assessed valuation, for selected townships, in 1945*

Township	Range in total school tax	Range in total property tax
Addison	$ 0.00 to $ 37.96	$16.12 to $ 54.08
Avon	10.80 to 124.44	56.40 to 159.24
Bloomfield	20.08 to 62.20	47.64 to 89.76
Groveland	17.12 to 34.28	38.24 to 55.36
Holly	17.04 to 43.80	39.68 to 66.44
Independence	16.44 to 80.40	41.40 to 105.36
Lyon	17.88 to 33.08	36.40 to 51.60
Novi	16.60 to 49.80	39.00 to 72.20
Orion	19.16 to 68.30	39.20 to 89.36
Oxford	24.40 to 58.40	50.80 to 84.80
Rose	18.44 to 36.89	42.54 to 60.94
Southfield	42.10 to 121.52	86.50 to 165.96
Springfield	19.72 to 39.44	40.84 to 60.56
Troy	17.36 to 102.26	59.16 to 163.16
West Bloomfield	4.76 to 46.72	30.44 to 93.68
White Lake	18.72 to 37.44	36.00 to 54.72

visors in the different townships of the same county do not necessarily assess alike, and the variation in the different townships of Oakland County in 1945 will be indicated later. Still later, by the application of the county equalization factor, these figures will be made comparable.

TAX VARIATION IN HOLLY TOWNSHIP, PER $4,000 ASSESSED VALUATION, BY SCHOOL DISTRICTS, IN 1945

Holly Township has eight school districts that lie wholly or largely within its boundary. Taxes for five purposes are uniform throughout the township. These taxes, per $4,000 assessed valuation, in 1945 were $12.80 for county purposes, $1.84 for county debt service, $4.00 for township purposes, $2.00 for fire protection, and $2.00 for library. The total property tax and the tax for school operation, and for school debt services, by school districts, per $4,000 assessed valuation, were as follows:

School district	School operation	School debt service	Total property tax
No. 1F, Stony Run	$32.00	....	$54.64
No. 2, Newark	38.32	....	60.96
No. 4, Five Points	21.32	....	43.96
No. 5, Olive Branch	17.04	....	39.68
No. 6, Holly	32.00	$11.80	66.44
No. 7, Patterson	17 12	9.50	49.08
No. 8, Willover	19.16	....	41.80
No. 9, Traphagen	38.32	....	60.96

All of the 36 sections or square miles of Holly Township, except for 80 acres, lie in the Holly trade and high school attendance areas. About 60 square miles in Rose, Springfield, and Groveland townships also lie in the Holly trade and high school attendance areas. A combination of the 19 school districts in the Holly community would adequately meet the specifications of a single community school district in terms of valuation and high school enrollment.

The variation in taxes for educational purposes and in total property tax is not large in Holly Township, nor in any other township in the northern part of Oakland County, as compared with a majority of the townships in the southern, eastern and central parts of the county in which phenomenal increases in population and in farm land values have been experienced, in recent years.

TAX VARIATION IN AVON, TROY, AND SOUTHFIELD TOWNSHIPS, PER $4,000 ASSESSED VALUATIONS, BY SCHOOL DISTRICTS, IN 1945

Avon Township has 11 school districts lying wholly or largely within its boundary. Taxes for four purposes are uniform throughout the township. On the basis of $4,000 assessed valuations, they are, $16.20 for county service, $2.40 for county debt service, $10.80 for township service, and $5.40 for a special fire fund. The total property tax and the tax for school operation and for school debt service, by school districts in Avon Township per $4,000 assessed valuation, in 1945 were as follows:

Number and name of school district	Tax for school operation	Tax for school debt service	Total property tax
No. 1F, Stony Creek	$10.80	....	$45.60
No. 2F, Avon	48.60	$75.84	159.24
No. 3, Brooklands	36.20	71.84	142.84
No. 4, Hamlin	47.28	27.00	109.08
No. 5, Rochester	54.04	16.20	105.04
No. 6F, Brewster	52.96	....	87.70
No. 7, Ross	33.48	....	68.28
No. 8, Hubble	21.60	....	56.40
No. 9, Christian Hill	36.72	....	71.52
No. 10, Elmwood	43.20	32.40	110.92
No. 11F, Stiles	51.88	54.04	140.72

Rapid increase in population means increases in school enrollment, teachers, and additional school buildings and equipment. Between 1940 and 1947 the population in Avon Township increased from 8,776 to 11,067, an increase of 26 percent.

In 6 of the 11 school districts in Avon Township there was a tax for school debt service, and in three of them it was greater than that for school operation. The school districts with school debt services are in the southern half of the township in which the most rapid population growth and most extensive suburban developments have taken place.

The Elmwood and the Stiles School districts and Troy No. 10F were combined in November 1947, with the Auburn Heights School District in Pontiac Township to form a single school district. All of the other school districts of Avon Township lie in the Rochester high school attendance area. The tax for school operation and for school debt service in the Rochester School District in 1945 totaled $70.24 per $4,000 assessed valuation. This is a lower figure than in the Avon,

Brooklands and Hamlin School districts in which the tax for total school purposes was $124.44, $108.04, and $74.28, respectively. The creation of a township school district, or preferably, the organization of a Rochester community school district, would equalize the tax load.

Troy Township has nine school districts wholly or largely within its boundary. Taxes for five purposes were uniform throughout the township. These taxes, per $4,000 assessed valuation, were $15.32 for county purposes, $2.20 for county debt services, $4.04 for township drain, $12.24 for township purposes, and $8.00 for township debt service. Most of the farmers throughout the township with $4,000 assessed valuation were also taxed $19.20 for the Featherly Drain, and in one school district, No. 10F, they were taxed $8.30 for the Sprague Drain. The total property tax and the tax for school operation and school debt services, by school districts in Troy Township, per $4,000 assessed valuation, in 1945, were as follows:

Number and name of school district	Tax for school operation	Tax for school debt service	Total property tax
No. 1F, Troy-Union	$40.88	$61.38	$163.16
No. 2, Troy	49.04	42.16	133.00
No. 3F, Leonard	17.36	....	59.16
No. 4, Troy-Smith	41.88	....	83.68
No. 5, Colerain	38.32	30.64	110.76
No. 6, Big Beaver	35.76	30.64	108.20
No. 7, Log Cabin	49.04	35.76	126.60
No. 8, Poppleton	38.32	....	80.12
No. 10F, Troy-Stone	35.76	30.64	116.50

Six of the nine school districts in Troy Township have tax levies for debt service, of which five are approximately equal to the tax for school operation, and in one it exceeds that for school operation. Between 1940 and 1947, the increase in population in Troy Township was 28 percent, from 8,505 to 10,921. This increase in total population gives a clue to the increased needs for additional school buildings, equipment, and teachers. In the Troy-Union School District, the school census (children ages 5 to 19 inclusive) showed 84 in May 1936, and 231 in May 1947.

Southfield Township in 1945 had 11 school districts lying wholly or largely within its boundary. Taxes for four purposes were uniform throughout the township. These, per $4,000 assessed valuation in 1945 were $23.40 for county purposes, $3.36 for county debt service, $4.72 for township drain, and $12.96 for township purposes. The total tax and the taxes for school purposes were as follows:

Number and name of school district	Tax for school operation	Tax for school debt services	Tax voted for increased school millage	Total property tax
No. 1, Old Parker	$46.80	....	....	$91.24
No. 1F, Franklin	49.96	$27.32	$19.52	141.24
No. 4, East Southfield	39.00	48.00	....	131.44
No. 5, Brooks	50.72	....	....	95.16
No. 6, Angling Road	42.10	....	....	86.50
No. 7, McKinley	31.20	28.00	....	103.64
No. 8, Brace	37.44	23.44	....	105.28
No. 9, John Grace	46.80	40.00	....	131.24
No. 10, Southfield	59.12	15.60	46.80	165.96
No. 11, Lathrup	41.36	17.56	....	103.36
No. 12, Magnolia	40.44	....	5.84	90.72

Eight of the 11 school districts in Southfield Township in 1945 levied taxes for school debt service or taxes for school purposes beyond the 15-mill tax limitation for all purposes on state-equalized valuation. This township increased 64 percent in population from 1940 to 1947, that is, from 8,468 to 13,913. Between May 1936 and May 1947 the school census total had increased in the Brace School District from 91 to 528, in Southfield School District from 151 to 555, and in Lathrup School District from 50 to 333.

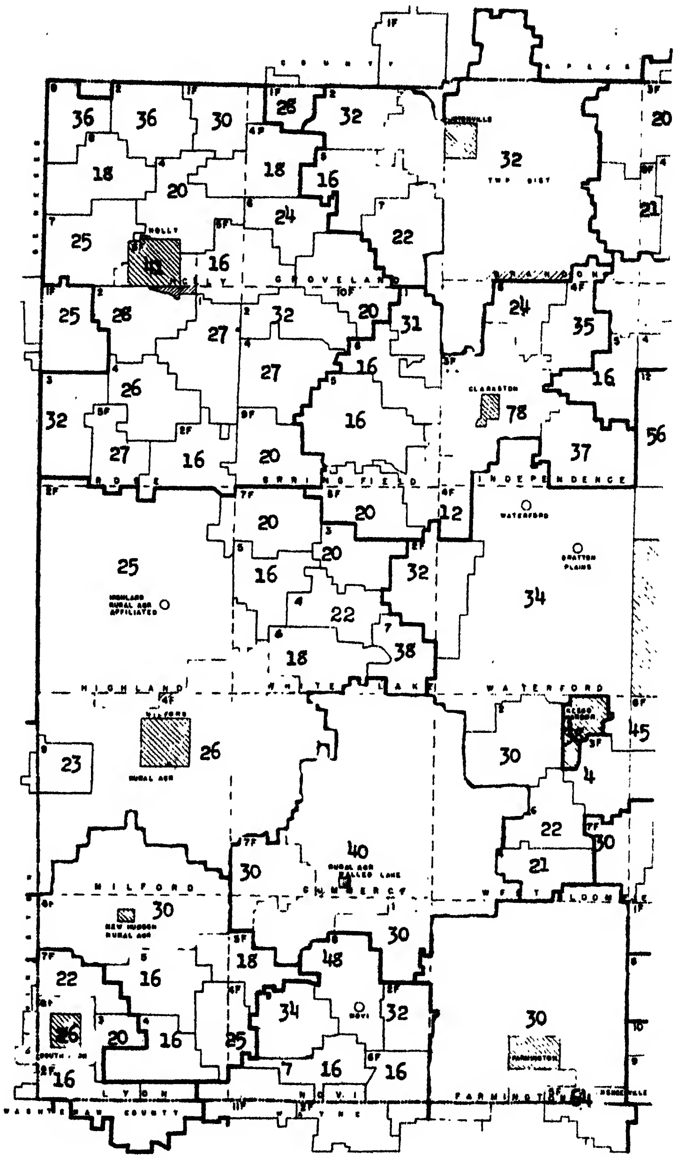
Farmers in the different school districts of Avon Township, with the same assessed valuation ($4,000), in 1945 paid property taxes of $45, $56, $68, $71, $87, $105, $109, $110, $140, $142, and $159.

In Troy Township, farmers in the various school districts, with $4,000 assessed valuations, in 1945 paid property taxes of $59, $80, $83, $108, $110, $116, $126, $133, and $163.

In the different school districts of Southfield Township, farmers with $4,000 assessed valuations in 1945 paid property taxes of $86, $90, $91, $95, $103, $105, $131, $141, and $165.

In each of the foregoing three townships, the differences in the total property tax paid by farmers with the same assessed valuations were due largely to differences in total school costs, including debt service, in the various school districts. In 1945 in three-fourths of the 141 school districts considered in this study, more than one-half of the total tax dollar went for school purposes, which included debt service and special millage for building and site funds.

The differences in costs among the school districts do not necessarily reflect corresponding differences in either the quality or quantity of curricular offerings or educational benefits. The tax load of farmers within these townships will continue to vary considerably and



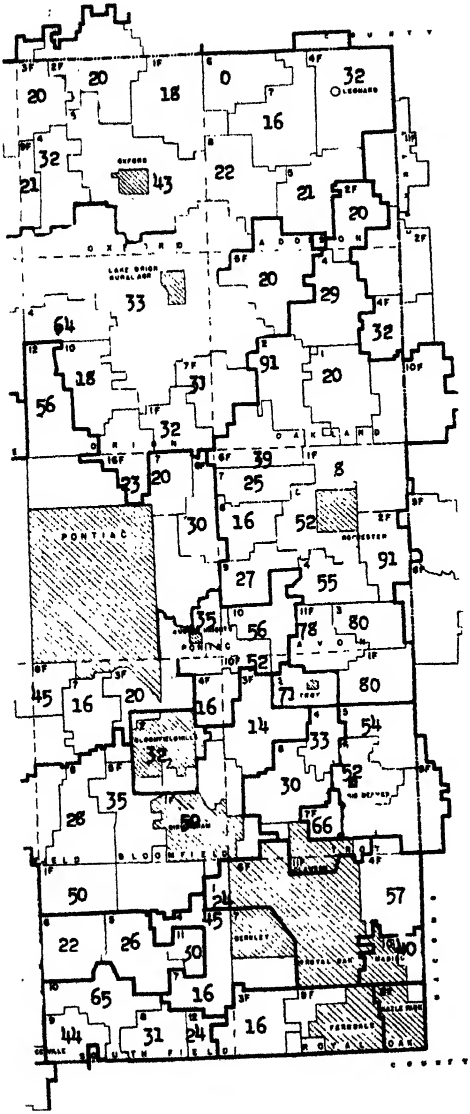


Fig. 3. Tax for school purposes, including school debt service and building and site funds, on $4,000 assessed valuation, as equalized by school districts, in 1945.

rest unduly heavy on some as long as the townships are split up into numerous taxing units, sometimes more than a dozen. Occasionally a small taxing unit may have tremendous taxable wealth and others may have very little. Chance or luck is frequently the primary reason for irregular distribution of taxable wealth. Enlarged taxing units have materially equalized taxes in the townships of Highland, Commerce, Brandon, Milford, Lyon, and Southfield, as will be indicated later.

Several times on preceding pages attention has been called to the fact that a comparison of taxes among school districts in different townships was not strictly comparable because of the differences in the assessment ratios to true value. For that reason, the Oakland County Board of Supervisors annually examine properties and compare assessment rolls of the several townships and cities within the county and equalize the same by adding to and deducting from the valuation of the taxable property in the several townships and cities so assessed, such an amount as in its judgment will produce relatively an equal and uniform valuation of the taxable property in the county. In 1945 the assessed valuation was as little as 51.3 percent of the county-equalized valuation in Southfield Township, and as much as 96.8 percent in Novi Township. The valuations as determined by the County Board of Supervisors was approximately two-thirds of the true market value in 1945.

TAX VARIATION FOR SCHOOL PURPOSES, IN OAKLAND COUNTY

Figure 3 shows for each school district in Oakland County (excluding Pontiac, Royal Oak and several other districts in which few or no farmers reside) the amount of property tax levied on assessments of $4,000 as equalized (by the County Board of Supervisors), in 1945, for all school purposes, including debt service and special millage voted for building and site funds.

On the basis of $4,000 assessment as equalized, taxes for county purposes and county debt service were uniform throughout the county, namely $12 for the support of the county and $1.75 for county debt service. No taxes were levied for township purposes in Addison Township. In the other 24 townships this figure varied from $1.02 in White Lake Township to $10.50 in Independence Township. Two townships

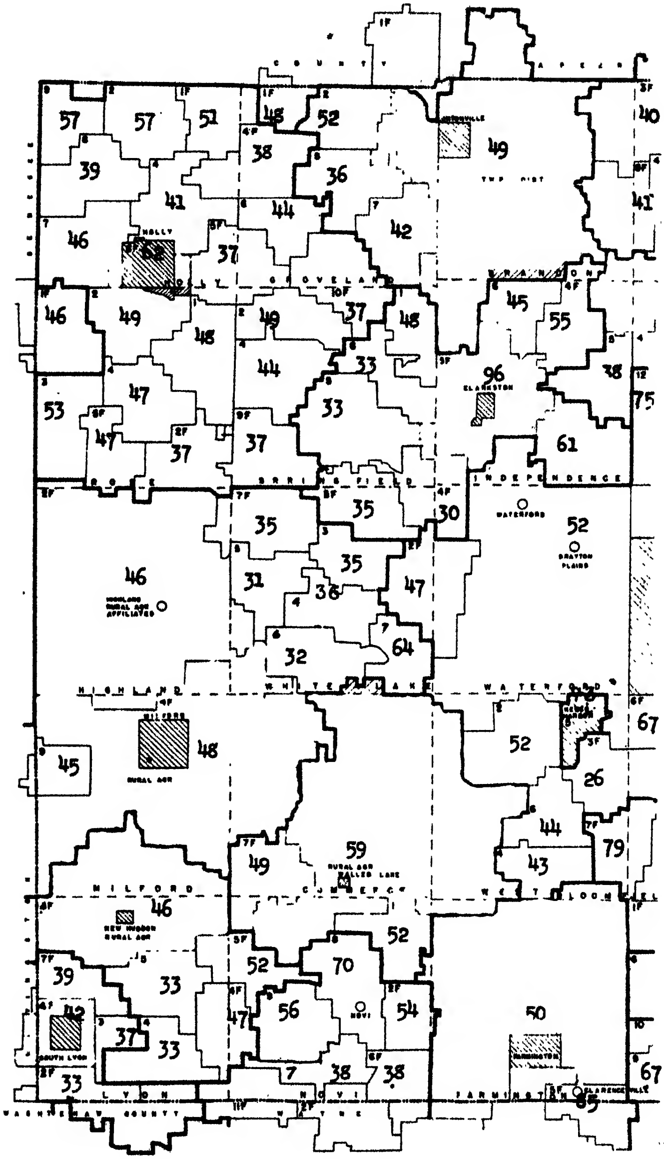
levied taxes for township debt services, namely Troy with a levy of $6.26 and Royal Oak with a levy of $8.68. Some townships also had one or more special tax levies for such purposes as drains, library, fire-fighting equipment, garage, cemetery, veterans' council, and others, which in some townships were included in the township levy.

The property tax, per $4,000 assessed valuation as equalized, varied considerably in Oakland County, namely from nothing in Addison No. 6 to $91 in Avon No. 2F and in Oakland No. 2. The range within some high school attendance areas may also be noted. These attendance areas frequently coincide with the town-country communities, or trade and service areas of villages. The range in Holly community was from $16 to $41; in Oxford community from nothing to $43; in Rochester community from $8 to $91; in Clarkston community from $12 to $78; and in Lake Orion community from $18 to $64. These differences do not necessarily reflect corresponding differences in quality of education. Combining school districts would reduce the differences in school taxes and increase opportunities for improvement in the quality of education.

TOTAL PROPERTY TAX VARIATIONS, BY SCHOOL DISTRICTS, IN OAKLAND COUNTY

Figure 4 shows by school districts in Oakland County the amount of property tax for all purposes levied on farm assessments of $4,000 as equalized (by the County Board of Supervisors) in 1945. The range was from $14 in Addison No. 6 to over $100 in seven districts, three of which were in Avon Township, two in Troy Township, one in Royal Oak Township, and one in Oakland Township. The costliest was in Troy No. 1F.

The range within some communities (high school attendance areas) may be noted, namely from $37 to $62 in Holly; from $14 to $63 in Oxford; from $34 to $128 in Rochester; from $30 to $96 in Clarkston; and from $37 to $84 in Lake Orion. The formation of community school districts would equalize these taxes as it has in eight communities and townships of Oakland County. Combination of school districts would normally increase the tax for the low tax payers, decrease it for the high tax payers, and remain unchanged for some.



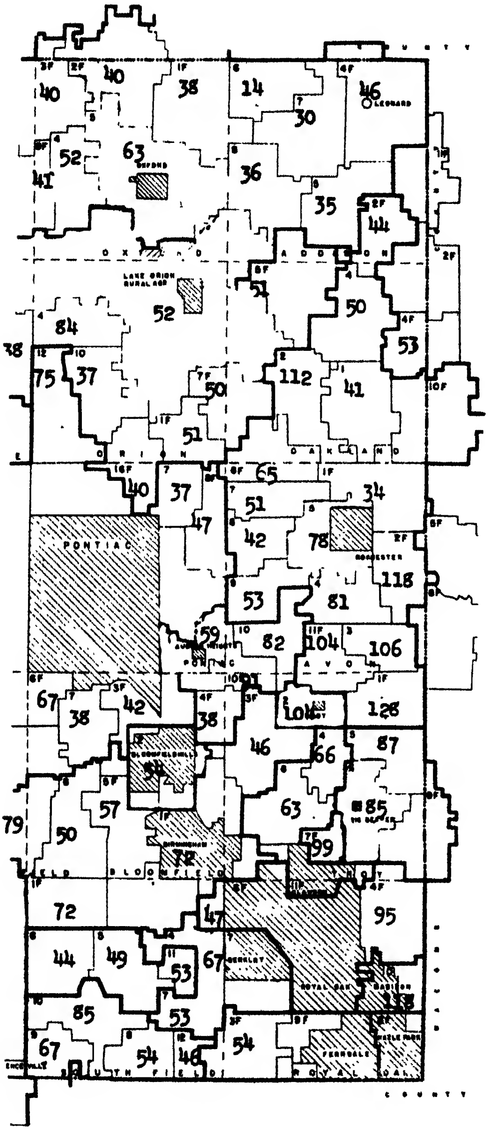


Fig. 4. Total property tax on $4,000 assessed valuation, as equalized, by school districts, in 1945.

EQUALIZATION OF TAXES THROUGH ORGANIZATION OF COMMUNITY OR TOWNSHIP SCHOOL DISTRICTS

About one-third of the farmers in Oakland County now live in areas where the tax loads have been substantially equalized. The larger areas involved in these reorganizations are indicated in Fig. 5. In Walled Lake community, in 1921, the year before the organization of its Rural Agricultural School District, a person with property assessed at $4,000 paid only $32.24 total school tax if he lived in one of the seven districts included within the merger, and as much as $62.10 total school tax if he lived in the costliest of the seven tax districts. Both districts were in Commerce Township. The difference in cost probably had little or no relation to the difference in the quality of instruction or the richness of the educational environment. The total property tax on $4,000 assessments, in 1921, in the cheapest of the seven school districts was $106.48 and in the costliest, $202.76, and both were in Commerce Township. The next year it was $165.20 for the entire area.

In Highland Township, in 1921, the year before the merger of its six school districts, farmers and property owners having property assessed at $4,000, paid school taxes which ranged from $13.32 to $33.68. This figure was $25.44 in 1922 and uniform throughout the entire combined area. The total property taxes ranged from $97.24 to $117.60 the year before the township school district was formed, and it was $97.80 for the new combined area the following year.

The Milford Rural Agricultural School District represented a seven-district merger in 1922-23 in which property owners with $4,000 assessed valuations the previous year paid as little as $9 in one district for the support of their schools and as much as $60.08 in the costliest school district, and all seven districts were lying largely in Milford Township. The figure was uniformly $51.20, in 1923, in the new, enlarged district. Just before reorganization, the total tax for all purposes was $125.80 in the lowest taxing unit and as high as $195.36 in the highest. In 1923, the tax was uniformly $173.36.

In Waterford Township, in 1941, the total school tax varied from $20 to $69.20 and the total tax from $53.92 to $103.12 per $4,000 assessed valuations, while in 1942, the year of the organization of the Waterford Township School District, the school tax was $52 and the total tax was $84.44.

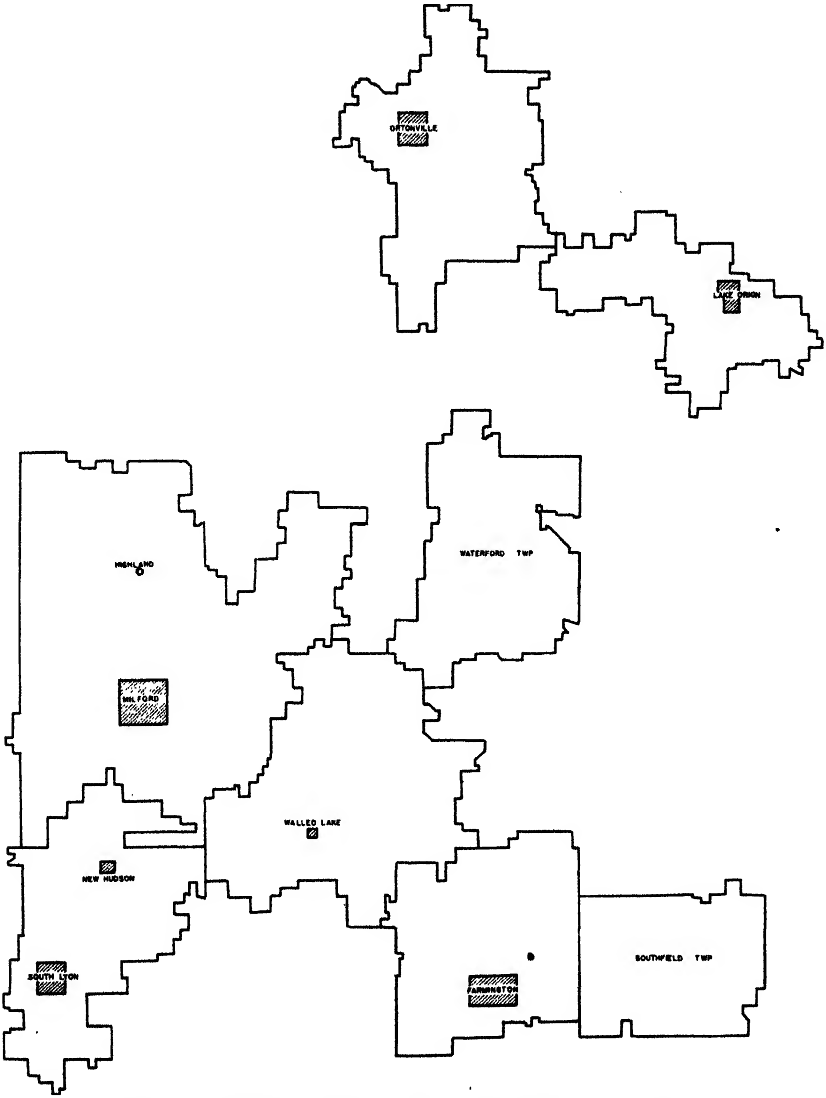


Fig. 5. School district reorganizations in Oakland County.

In 1942, in Brandon Township, the total tax varied from $11.32 to $49.32 per $4,000 assessed valuation. In contrast, in 1943, the year the Brandon Township School District was formed, the total school tax was $22.80 and the total tax was $38.32.

Similar equalization of school taxes and of total taxes took place in other school district reorganizations, such as those in the communities of Lake Orion, Farmington, Bloomfield Hills, Birmingham, Auburn Heights, and in Southfield Township. In several of these the reorganizations and annexation took place since 1945.

Many factors have induced school district reorganizations in the county. Of first importance is possibly the element of unusually able educational leadership extending over a period of at least a quarter-century. This county pioneered in school district reorganization soon after the Rural Agricultural School District Act became operative in 1919. Recently, many reorganizations have been stimulated by migrants from the city who demanded for their children the same enriched, educational environment, they had previously experienced in the larger graded urban districts. The children of long-established residents naturally benefited, educationally, from such resulting reorganizations and curriculums.

STATE EQUALIZED VALUATION PER SCHOOL CENSUS CHILD

Wealth is very unequally distributed, even within townships and communities. This is indicated, in part, by the wide variation in the amount of wealth per school child, by school districts. One school district may have many children but little taxable wealth and another may have few children but much highly restricted resort property, manufacturing plants, power dams, or other concentrated taxable wealth.

In 1941, Oakland County had as little as $851 of state-equalized valuation[1] per school census child in one district and as much as $26,933 in another district. Such a situation frequently results in an economically poor district having a high tax rate, especially for school purposes, and a wealthy district having a low tax rate. Reorganization of school districts into township school districts and into rural agricultural school districts tends to level-off inequalities. However, reorganization is sometimes stymied by electors in the wealthy district refusing to participate, since it means a sharing of their taxable wealth and a raise in their light or moderate tax load.

[1]The ratio of assessed valuation to true market values varies considerably in different counties. Therefore, for purposes of distributing state aid equitably, a State Board of Equalization assigns valuations to each county.

On November 7, 1944, the electors of Farmington Township, excepting the Clarenceville School District, voted to become a single school district. In 1943, in the eight school districts comprising this union, the state-equalized valuation per school census child ranged from $1,830 in No. 6 to $10,786 in No. 1F. The next year, with a school census total of 1,807 and a state-equalized valuation of $7,611,183, the valuation per child within the township school district was $4,212.

Southfield Township School District is a recent reorganization. In 1945, the year before its organization, No. 6 had a state-equalized valuation of $3,524 per school census child, while No. 11 had $13,146, and No. 12 had $13,193. The next year, as a result of the union of these eight districts the school census totaled 3,019 and the state-equalized valuation totaled $17,308,732, or $5,733 per child.

The South Lyon Rural Agricultural School District has just been formed out of six districts, including the New Hudson Rural Agricultural School District, which was a three-district merger in 1923. In 1946. the range in state-equalized-valuation-per-school-census child in these six districts varied from $5,241 to $10,091.

The task of equalizing the tax load locally in Oakland County, despite the reduction in the number of school districts from 202 in 1920 to 121 school districts at the present moment, is less than half complete. Property owners in many localities are considering the practicability and desirability of increasing educational opportunities for their children. Proponents of school district reorganization have many followers in those sections in which inequalities are not too great. The present increase in some taxing units of tar paper shacks and basement houses filled with large families, property restrictions, and the movement of high taxable properties into other taxing units, tend to accentuate inequalities. Nobody likes to adopt an "orphan" taxing unit. Tax payers who live in "milk and honey" taxing units do not care to share their luck and taxable wealth. The tax loads of many other tax payers of this county could be considerably lightened by the formation of more township or community school districts. However, in any comprehensive reorganization of taxing units, about one-third of the property owners will experience a rise in taxes. Such tax payers are more likely to endorse and support reorganization when they are thoroughly sold on the merits of adequate equalization of educational opportunities for all children, including their neighbor's children.

SUMMARY

In 1920, Oakland County had 242 units of government, each with taxing and debt-incurring powers. On January 1, 1948, this county had 172 units of government—one county, 25 townships, 12 cities, 13 villages, and 121 school districts. Tax rates vary considerably among governmental units, especially between school districts, even within townships and communities. Such equalization of taxes as has taken place in this county was accomplished largely through the merging of 72 school districts into eight school districts and the annexation of some primary school districts to the graded districts.

Continued suburban development is very likely in Oakland County. This county is conveniently near for many Detroiters and other Wayne County urbanites who commute daily, and for many others who maintain summer homes on Oakland County's numerous lakes. Zoning can curb the development of sub-marginal housing which is a fire hazard and a health menace. This requires community enlightenment and action. Through zoning ordinances, good land might be preserved for agriculture, but to do so the owner must be lured by greater inducements than that promised by suburban real estate promoters. Also through zoning, subdivisions might be restricted to less productive agricultural areas.

A restudy of the tax equalization of all units of government in Oakland County seems desirable. The present basis of tax equalization is a Michigan State Tax Commission survey based on 1941 and 1942 figures and property sales. Since then there have been tremendous changes in amount of land in farms, in population, in new dwellings, in taxable wealth, and in government costs. According to the United States Census of Agriculture for 1940 and for 1945, all land in farms decreased about 15,000 acres in eight townships and increased about 27,000 acres in the other 17 townships, while the value of farm land and buildings decreased nearly a million dollars in three townships and increased by more than 15 million dollars in 22 townships. Considerable acreage has been taken off the tax rolls for recreational purposes in recent years. It is estimated that the Michigan State Department of Conservation and the Huron-Clinton Metropolitan Authority already own nearly 40,000 acres in the county which are being developed into parkways, new lakes, and playgrounds for the two million persons in the Detroit Metropolitan District. Such changes demand frequent revaluation of property assessments in order that they be just and equitable.

PROTECTION OF VEGETATION FROM FROST DAMAGE BY USE OF RADIANT ENERGY—PART III

By F. J. HASSLER,[1] C. M. HANSEN,[2] and A. W. FARRALL[3]
SECTION OF AGRICULTURAL ENGINEERING

THE AGRICULTURAL Engineering Department of Michigan State College has continued its development of the use of infrared radiant energy for the protection of vegetation from frost damage. Reports on previous work done in this field may be found in the Michigan Agricultural Experiment Station Quarterly Bulletins, Vol. 29 No. 2 and Vol. 30 No. 1.

The objective of the experiments during the past year was to develop an effective unit which would be a sound investment to the farmer. Many designs were considered, and the three most practical units were tested during natural frosting conditions. This is a report of three experiments with the three units.

EXPERIMENT I

Description of Apparatus

The units used for this experiment were given the designations, "Type A" and "Type B" (Fig. 1). The relative merits of each unit are given as follows: Type B gave better energy distribution than did Type A, and therefore is more efficient. Type B gave the same radiation intensity as Type A at 120 feet distance from the unit when burning only 75 percent as much fuel. However, Type B involves a greater initial investment cost, since both the material and construction costs are greater.

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ARTICLE 30-46

Type A Type B

Fig. 1. Type A unit at left with Type B unit on the right. This was the set-up for Experiment I.

Procedure for Testing

The weather report of October 9, 1947, predicted a possible frost for that night, and plans were made to test the units. The units were placed in an east-west direction 130 feet apart with "A" west of "B" (Fig. 1).

Potted coleus plants, taken from the greenhouse were photographed (Fig. 2), and spaced at 10-foot intervals between the units. Three plants were also set at varying distances south of the midpoint between the units (Fig. 3) in order to obtain the effect of varying distances, beyond the midpoint. The pots were placed in the ground to a depth which brought the top of the pot on a level with the ground surface. A control plant was located 300 feet east of "B". This location was beyond the effective range of the radiation. This arrangement was intended to determine the extent of area protection which the two units operating simultaneously would provide.

Radiation intensities were taken at 10-foot intervals at the ground level to a distance of 120 feet from the units.

The air temperature was taken 1 inch above the ground with mercury bulb thermometers. One thermometer was located out of the effective radiation range—alongside the control plant, while another was located at the midpoint between the units.

Fig. 2. Greenhouse grown coleus plants before Experiment I. Starting at 20 feet from A unit, the plants were taken from left to right and spaced 10 feet apart, covering the distance between the units.

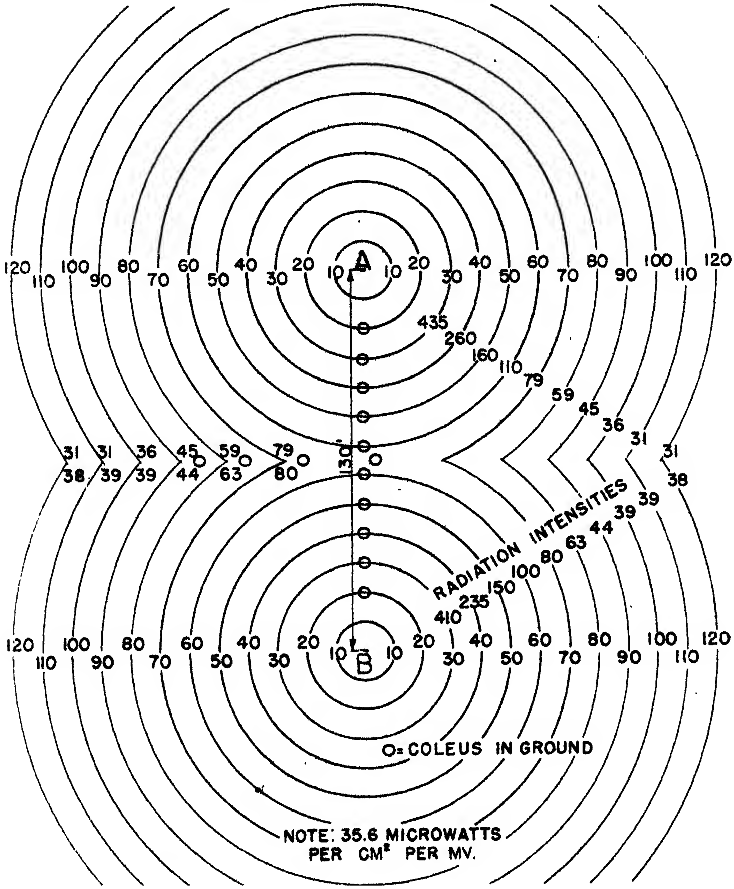


Fig. 3. Diagram of test set-up, giving distance between units, location of coleus plants, and radiation intensities in microvolts at 10 foot intervals from each unit. Note that total radiation intensity at a given point is the sum of the intensities from each unit at that point. The overlapping radiation is an important factor in the use of these units.

Data and Results

The units operated satisfactorily throughout the night without maintenance. Type A used approximately 14 gallons of fuel an hour, while Type B used 10 gallons an hour. The radiation intensities recorded in Fig. 4 are in accordance with data obtained during previous tests of these units.

TEST DATA FOR FROST PREVENTION UNITS

DATE 10-9-47 TAKEN BY F. J. HASSLER, L. H. LAMOURIA

PLACE NORTH OF FARM CROPS LABORATORY M. S. C.

TYPE OF UNIT "A" AND "B" TYPE OF BURNER AEROIL

MODIFICATION OF UNIT INCREASED BURNER CAPACITY

CENTER LINE HEIGHT OF UNIT 12'-6"

NOTE: ILLUSTRATED DRAWING OF UNIT
1 CLEAR, COOL, NO WIND
2 SURROUNDING AIR TEMP TAKEN AT 1' ABOVE GROUND

TIME UNIT STARTED	TIME TEST STARTED	TIME TEST ENDED	ELAPSED TIME	WEIGHT OF FUEL AT START OF TEST	WEIGHT OF FUEL AT END OF TEST	WEIGHT OF FUEL CONSUMED	POUNDS PER HOUR	GALLONS PER HOUR	TIME TAKEN	TEMP OF SURROUNDING AIR	TEMPERATURE OF RADIATING SURFACES AT					OIL PRESSURE
A- 10:25								APPROX 14	10:25	33						42 PSI
									11:00	30.5						
B- 10:20								10	11:30	29.2						35 PSI
									2:00	28.0						
									4:00	27.3						
									6:00	26.4						

RADIANT ENERGY MEASURED IN MICRO-VOLTS

TIME	10'	20'	30'	40'	50'	60'	70'	80'	90'	100'	110'	120'	130'
A 1:45	1300	1000	435	260	160	110	79	59	45	36	31	31	
B 1:40	1400	700	410	235	150	100	80	63	44	39	39	38	

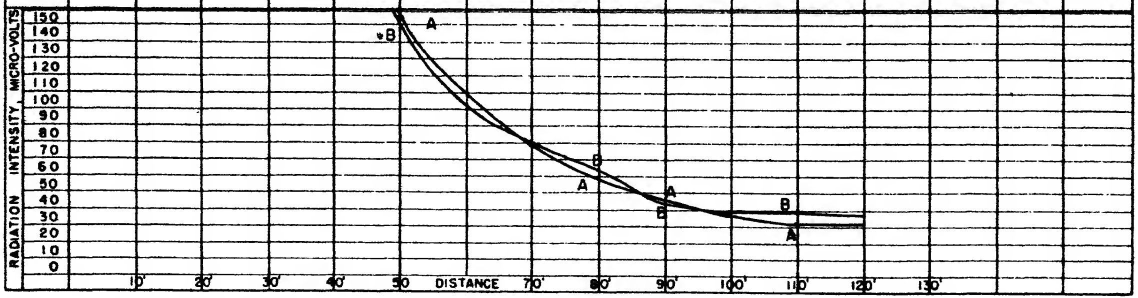


Fig. 4. Test data, giving operating performance for both Type A and Type B units and weather conditions during the test.

TABLE 1—*Recorded temperatures in ° F.*

Time	Position 1: Midpoint between units	Position 2: 300 Feet east of "B" unit unprotected control position
10:25 P.M.	34	33
10:45 "	35	31
11:10 "	37.8	30.4
1:15 A.M.	34	28
2:15 "	34	28
3:15 "	34	27.5
4:00 "	34.1	27.3
5:35 "	33	26.5
6:15 "	31.5	26.4
7:00 "	34	32

A review of the temperatures tabulated in Table 1 gives the minimum air temperature as 26.4° F. The thermometer which was located at the midpoint, indicated temperatures as much as 7.5° F. higher than the temperature recorded at the control plant. A thick mat of blue grass sod covered the entire area over which this test was made.

Previous tests showed that when there was a grass covering, the air temperature was lowest at the ground and increased rapidly up to a height of one foot. Above one foot the air temperature gradually approached the general air temperature. The reverse is often found to be true for open or bare ground.

Investigations by Schilling *et al.* have determined that air temperature for a specific location may vary as much as 10° F. within a few seconds. However, the mercury bulb thermometer will not react to these rapid temperature changes and for this reason the temperature registered by this type of thermometer will be the average temperature for a short period.

The extent of the protection given the coleus plants and the surrounding blue grass was obvious with the coming of dawn. For the area, other than between the units, complete protection was noted on the grass to a distance of 50 feet with evidence of some protection out to as far as 150 feet. There was no frost on the grass between the units except for a few spots at the midpoint between the units where the grass had been crushed flat by walking and did not receive many of the direct rays.

65'A 60' 50' 40' 30' 20' Check

Fig. 5. Coleus plants after exposure. These were spaced at varying distances from the A unit up to the mid-point between the units. The coleus on the right was the control plant, set 300 feet east of B unit. Note the damage to this plant. Note that all of the plants which were subject to the radiation were undamaged. Plants at 40 and 50 foot distances appear different in the photo due to angle of photography but, leaves and stems actually were undamaged.

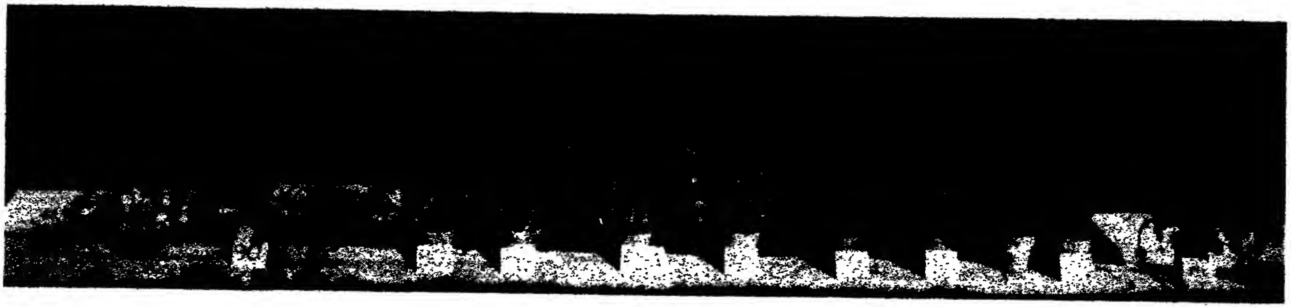


Fig. 6. Coleus plants after exposure. These plants were located between the mid-point and the B unit including those plants that were placed south of the mid-point to a distance of 90 feet from each unit. The plant at the extreme right is the control plant. Note the frost damage on that plant. The other plants were undamaged.

The coleus plants which were placed at an angle from the direct line between the units but within 90 feet of them (Figs. 5 and 6) were completely free from frost except for the bottom leaves of the plant located at 90 feet from each unit (Fig. 3). These leaves were touching the ground. The control plant was frosted to a height of 16 inches with the severity of frost formation decreasing with elevation.

Discussion

The results of this test were encouraging from two standpoints: first, the units operated satisfactorily without maintenance for a period of 8 hours; second, vegetation was protected over a large area. However, these results are for only one set of weather conditions over a particular type of ground covering and since both of these factors greatly influence the results, it will be necessary to test the units under several conditions before a full evaluation can be made. The following conclusions are drawn from a consolidation and analysis of observations taken from this test and previous tests.

1. Units operating alone gave complete protection to blue grass to a distance of 50 feet, with noticeable protection to standing grass to a distance of 150 feet; however, frost will form as close as 35 feet on grass which has been injured by flattening.

2. Sensitive coleus plants were protected in the area between the two units. Plants placed on a line at right angles to the midpoint and measuring 90 feet from each unit, were also protected, while the control plants were severely damaged.

3. When the ground is covered with vegetation such as grass, the air temperature will be lower at the ground during periods when weather conditions permit radiation losses. Also, the ground supplies only a small amount of heat to vegetation that is growing above the grass. This indicates that more radiation would be needed for this set-up than when much bare ground was exposed.

4. It is reasonable to believe that satisfactory protection would be afforded with units spaced further apart, when more than two units are operating simultaneously due to the overlap of radiation from the different units.

EXPERIMENT II

Purpose of the Experiment

Following the conclusive evidence that infrared radiant energy was effective as a means for large scale protection of vegetation from frost damage, it was decided to turn attention to the development of a unit that could be manufactured and sold at a cost which would be economically feasible. Since the intensity of radiation increases as

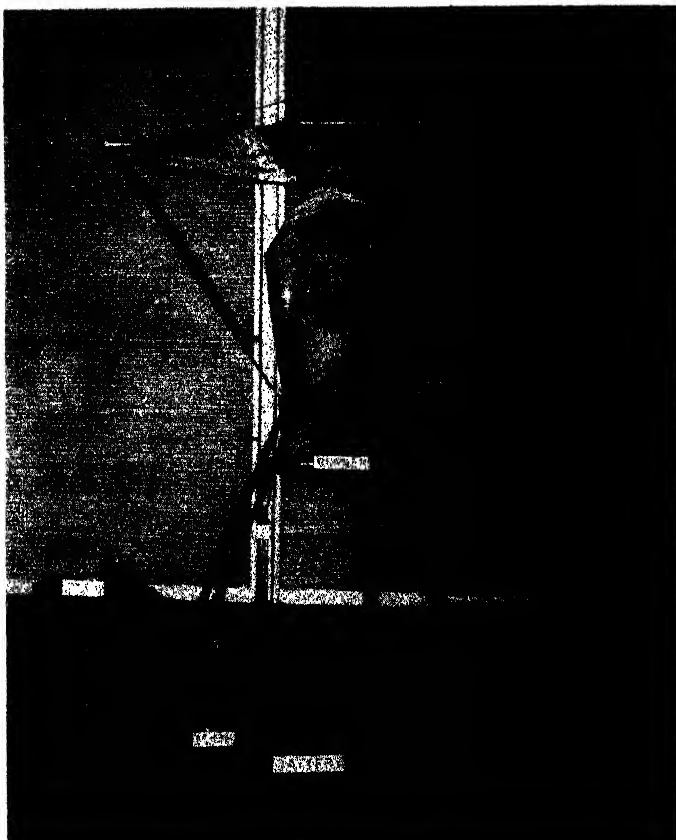


Fig. 7. Type AA unit with accessories. This unit operates at higher temperature than A or B units.

the fourth power of its absolute temperature, a logical improvement would be to operate at a higher temperature, making it possible to cut down the radiating surface, and still retain the effective area coverage. Owing to the excessive rate of oxidation for plain steel it was necessary to use a heat-resistant alloy to withstand the anticipated temperatures.

Description of Apparatus

A unit was constructed of aluminized steel and having only one-half the effective radiating surface area of the original Type A unit. This unit was designated as Type AA (Fig. 7). A test was made on this unit to compare its operating characteristics with the original Type A unit. The results of this test proved that the energy distribution pattern and intensity were comparable to the Type A unit when burning fuel at the rate of only 10 gallons an hour as compared with 14 gallons an hour for the original unit.

Procedure for Testing

On the night of November 14, 1947, units AA and A were set up on an east-west line with AA unit 130 feet east of A unit. The units were placed on the blue grass plot as described in Exp. I, alongside a freshly seeded wheat field. Greenhouse grown tomatoes, begonias, and geraniums were potted and placed at predetermined locations. A diagrammatic set-up is illustrated by Fig. 8. Control plants were located 350 feet west of Type A unit.

The units were put in operation after the air temperature had fallen below 30° F. The units were started and brought to the maximum temperature. The plants were then taken from the greenhouse and placed in the test area as shown in Fig. 8. The plants were exposed for two hours to allow them to reach a temperature equilibrium, after which they were returned to the greenhouse.

Air temperatures were taken with mercury bulb thermometers at intervals throughout the duration of the test. These temperatures were taken at varying elevations above the ground over a blue grass covering 350 feet west of A unit (Table 2).

Radiation intensities were taken at 10-foot intervals on the ground to a distance of 120 feet. An optical pyrometer was used to determine the surface temperature of the units. This was a total radiation meter calibrated for black body conditions.

The average wind velocity was determined over a 5-minute period.

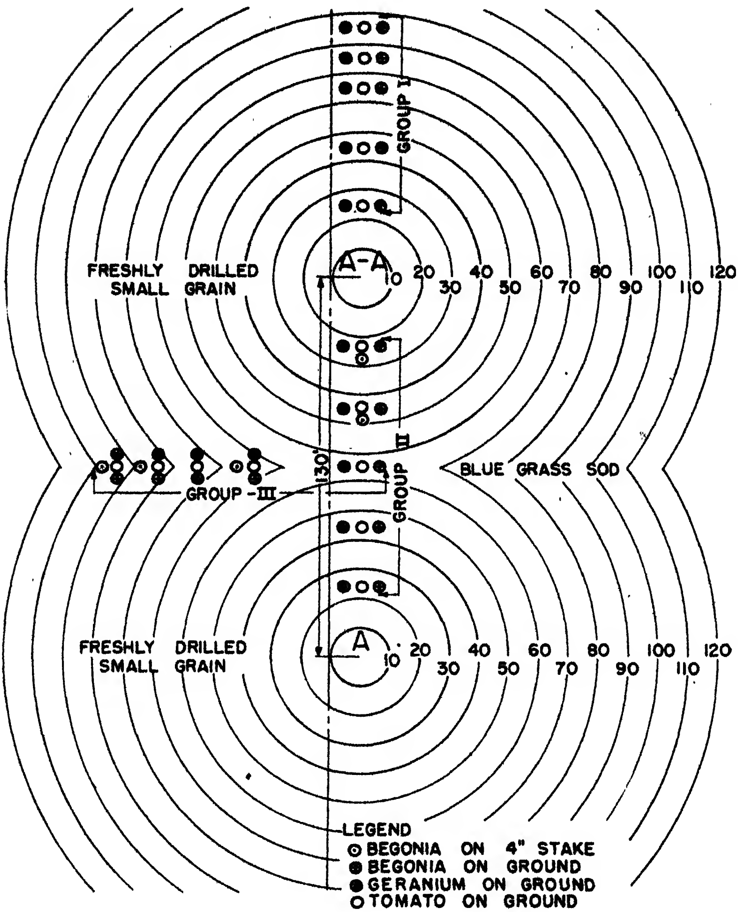


Fig. 8. Diagram of test set-up, giving location and grouping of plants for test on November 14.

TABLE 2—*Air temperature at 350 feet west of "A" unit*

Time	1 Inch above ground	2 Feet above ground	4 Feet above ground
9:15 P.M.	29.5° F.	30.0° F.	31.0° F.
10:00 "	29.4° F.	30.0° F.	31.0° F.
11:00 "	30.5° F.	31.5° F.	32.5° F.
12:00 "	32.0° F.	33.0° F.	33.5° F.

Data and Results

The sky alternated between slightly overcast and clear. An average 10-m.p.h. wind coming from the east prevailed throughout the test. These conditions reduced the likelihood of frost formation since radiation loss is slowed down by the clouds and the wind hinders condensation of moisture on the plants. Table 2 gives a maximum air temperature difference of only 2° F. between 1-inch and 4-feet elevations. This difference is much less than previous tests indicated for a grass-covered area. This small difference is ascribed to the prevailing weather conditions. The wind affected the operating characteristics of the burner, causing excessive cooling on the windward side. This resulted in lower radiating intensities and non-uniformity in the heating of the radiating surface as compared to previous tests.

At 1 inch above the ground the air temperature decreased until 10:00 p.m. at which time a low of 29.4° F. was reached. Following this, the temperature began a gradual rise reaching 32° F. at 12:00 midnight. The plants were exposed from 10:00 p.m. to 12:00.

Observation of the plants the following day revealed that none of them had been frozen. Even the control plants were in as good condition as before the test.

Discussion

This test was of no consequence as far as securing information which would serve to aid in determining the area protection that the units would give. However, the results do throw further light on the relationship between weather conditions and likelihood of frost damage to plants under certain conditions. Based on this test the following conclusions can be drawn:

1. Neither tomato, geranium nor begonia plants will freeze when the minimum air temperature is 29.5° F. if the sky is slightly overcast and accompanied by a 10-m.p.h. wind.

2. A 10-m.p.h. wind affects the uniformity of heating of the radiating surface of the type of units tested. This is caused by excessive cooling of the windward side and the blowing of the flame at the initial point of combustion.

3. The new radiation unit operating at a temperature of 1,500° F. gave approximately equal radiation to the old low temperature unit operating at 1,000° F. and having twice the radiation surface. The oil consumption was reduced from 14 gallons an hour to 10 gallons an hour.

EXPERIMENT III

Purpose of the Experiment

The results of Experiment II did not provide sufficient information as to the effectiveness of the units. For that reason plans were made to make another test even though it was late in the fall and the temperatures likely to be experienced would be considerably lower than those from which the agriculturist would normally have to protect his crops.

Type A and AA units were used for this test as in Experiment II. No modifications had been made on either unit following Experiment II.

Procedure

The weather report on November 20, 1947, gave a noonday temperature of 40° F. and predicted a clear sky for the early part of the night. Plans were made to test the same units as in Experiment II with an identical layout (Fig. 8). The air temperature had fallen to 36° F. at sundown and it was evident that low temperatures would be experienced shortly thereafter. Preceding this test there had been several days and nights of sub-freezing weather and the ground had been frozen to an appreciable depth.

The tomato, begonia, and geranium plants used in this test, were photographed immediately preceding the test. Similar shots were taken following the test. The plants were grouped as to their relative position with respect to the heating units (Fig. 8). Group I was made up of those plants east of AA unit, Group II was those plants between the units and Group III consisted of the plants that were placed on a

TABLE 3—*Air temperature in ° F.*

Time	1			2	3
	1 Inch	1 Foot	2 Feet	1 Inch	1 Inch
8:30 P.M.	19	27	23.4	....	....
8:55 "	20	28	29	....	....
9:15 "	22	29	30.5	16	19
9:45 "	22	28	29.5	18	20.5
11:00 "	27.5	31.5	33	22	20.5

Temperature in °F.
Location: 1— 325 Feet west of "A" unit in grass cover.
2— 300 Feet southeast of "AA" unit in grass cover.
3—1500 Feet southeast of "AA" unit in stubble.

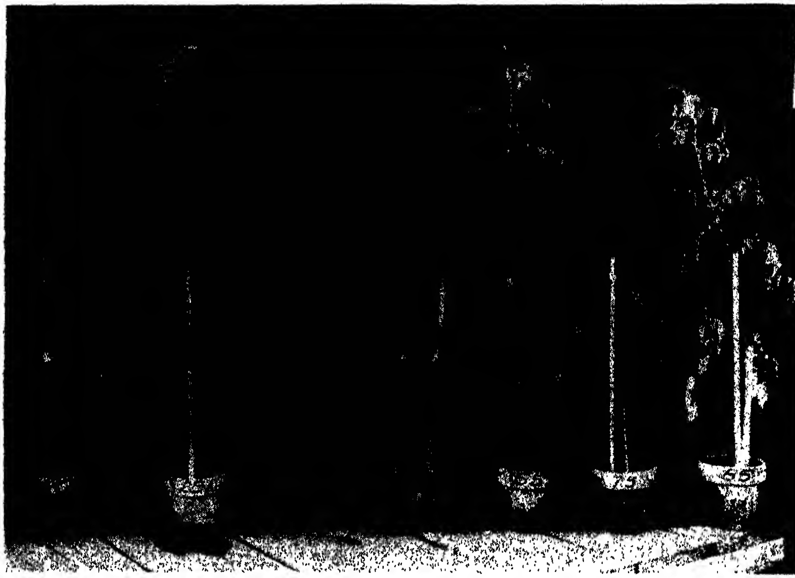
line perpendicular to the midpoint of the line connecting the units. Groups I and II were placed over a blue grass sod with grass blades to a height of 4 inches, while most plants of Group III were setting in open or fallow ground that had sparsely drilled wheat growing on it. The air temperature was taken with mercury bulb thermometers at 1 inch above the ground at three widely separated points (Table 3). Also the air temperature was taken at 1- and 2-foot elevations at one of these locations.

The units were started at 8:15 p.m., at which time the air temperature was noted to be 19° F. at 1 inch above the ground on the blue grass sod. The plants were exposed from 8:45 p.m. to 11:05 p.m. and were returned to the greenhouse. The surface temperatures of the units were taken with an optical pyrometer which was the same one used in Experiment II.

Data and Results

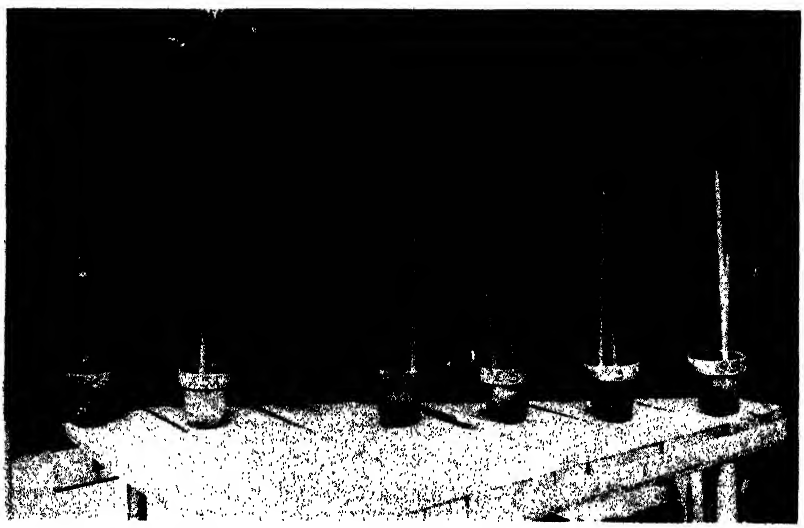
The air temperatures as given by Table 3 are significant in the pointing out of the temperature variation at different locations and the temperature difference associated with elevation. As previous experiments indicated, the air temperature over blue grass is lowest at the ground and rises sharply with an increase in elevation to the height of one foot. Locations No. 1 and 2 were over blue grass with the elevation of the ground surface at 2 approximately 3 feet higher that at 1. Location 3 was approximately 3 feet above location 2 and the plot was covered with a small grain stubble. The sky was perfectly clear with a slight drift in the air from east to west. These conditions were ideal for a high rate of heat loss from plants and ground by radiation; however, the air temperature was on a gradual increase throughout the test which is unusual for those prevailing weather conditions. This increase in air temperature is attributed to the drifting air since the usual trend is for the air temperature to decrease due to the radiation. Since points 1 and 2 of the temperature table were located on opposite sides of the test plot—2 being east and 1 west of the plot—an average of these two should give the approximate air temperature surrounding the plants which were located over the blue grass.

The results of this test are illustrated by the accompanying photographs. Each group consists of two photos, one taken before the test and one following. Figures 9 and 10 show plants of Group I, which were setting on the blue grass east of AA unit and received radiation



Check 25'A 45'A 65' 75' 85'

Fig. 9. Group I—Tomato plants before exposure to be located at indicated distances east of AA unit. Check plant to be located 325 feet west of A unit.



Check 25'A 45'A 65' 75' 85'

Fig. 10. Tomato plants of Fig. 9 after exposure. All plants were located over bluegrass and received radiation from one side only.

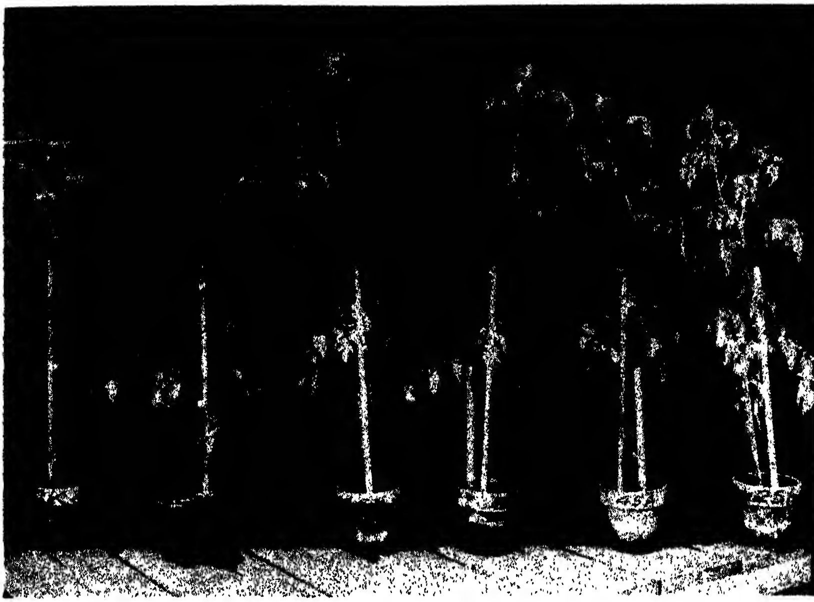
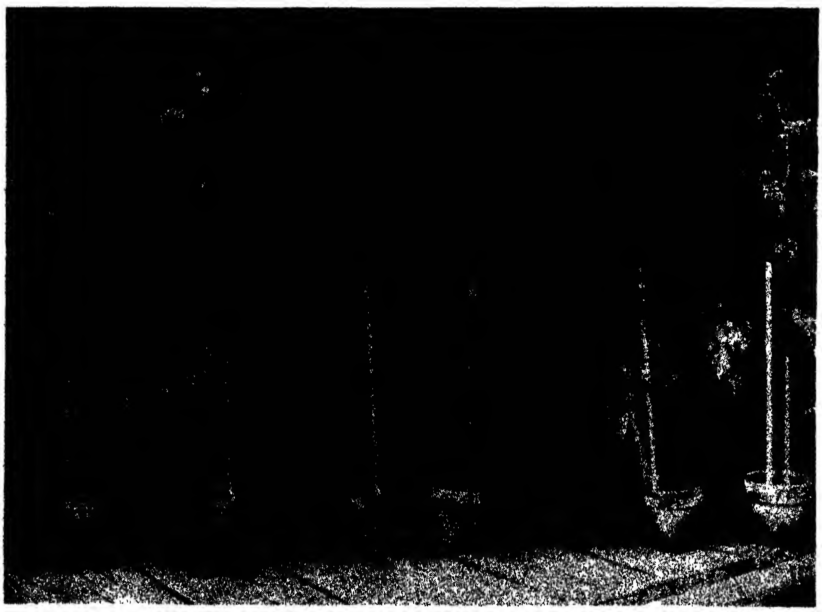


Fig. 11. Group II—Tomato plants before exposure to be placed between the units. The plants were placed from A unit starting at the left, excluding the check plant.

Fig. 12. Tomato plants shown in Fig. 11 after exposure.

from one side only. The numbers on the pots represent the distance in feet from the unit. The results indicate that the range of protection is less than 45 feet for one unit operating alone under these conditions. Figures 11 and 12 describe the plants in Group II. This group was located between the units where the ground was also covered with a solid growth of blue grass. The numbers give the distance from the units. Those numbers followed by the letter A are the distance from the AA unit while those followed by B signify the distance from the A unit. The plant marked 65 was located at the midpoint between the units. These photographs indicate that partial protection was afforded at 45 feet from the units for the area between the two units when spaced 120 feet apart.

Figures 13 and 14 represent Group III which illustrate an interesting phenomenon. From Fig. 8 it is noted that these plants are on a line perpendicular at the midpoint of the line connecting the units.



Check 65′ 75′ 85′ 95′ 105′

Fig. 13. Group III—Tomato plants before exposure to be placed on a line north of the mid-point equidistant from each unit. Includes the check plant and the plant located at the mid-point (pot marked 65). The numbers on the pots indicate the distance from each unit.

Fig. 14. Tomato plants shown in Fig. 13 after exposure. The plant at the mid-point (65) and the check plant were setting in bluegrass. All others were placed over open ground. Note the protection given plants at 75 and 85 feet, the severe damage to the plant at 95 feet, and the protection given the plant at 105 feet.

They extend into the freshly seeded plot of wheat. The control plant was out of the range of effective radiation while the pot marked 65 was at the midpoint between the units. Both the plant at 65 feet and the check plant, were located in the grass sod covering. The numbers on the pots indicate the distance in feet from each of the units—being equidistant from the units. The photographs point out that there were factors involved which affected the extent of protection other than the distance from the units. The reason for the plant at 65 feet freezing, while those at a greater distance did not, may be attributed to the difference in ground covering. This cannot be true for the plant at 95 feet since it was in the same plot as the plant at 105 feet.

The begonias and geraniums gave the same results. This rules out the possibility that the plant at 95 feet was less resistant, since the probability of three different plants having low resistance at the same point is not likely.

Discussion

The results of this test were informative and showed several unusual results.

This test was made under weather conditions which would not be considered as representative of the conditions during which damage would occur to Michigan crops. However, the results do bring out some interesting observations which would be applicable under natural conditions.

The primary concern of vegetable and fruit growers in this region is for protection against frost damage shortly after the planting and the budding season and for a few weeks before the end of the normal growing period. Freezing at these periods would be expected to be less severe since the sun has released more heat during the day, storing more heat in the ground and surrounding objects, which would carry plants through the night without their reaching as low temperatures as occurred in this experiment. Previous investigations have shown that the temperature of leafy vegetation might fall as much as 10° F. below the surrounding air temperature during a night. Under the conditions of this test this difference could be expected to be greater. The ground and surrounding objects were cold at the end of the day and could not provide any appreciable amount of heat for the plants. Also, there would be a lag between the plant and air temperature since the plants cool the surrounding air early in the evening, while the air would be warming the plants the latter part of the test. Both counts would favor a greater temperature differential between the two, with the plants being the lower since there is definitely a lag in the heat transfer. This would indicate that the surrounding air temperature would not be a fair basis for determining even an approximate temperature for leafy vegetation on clear nights.

It is of note that the plants at 105 feet from the units were not damaged, while those at 95 feet showed considerable damage in this experiment. There is no simple explanation for this result, but it may be that it was due to a difference in the radiation intensity at the two points as a result of imperfection in the radiation units, or more likely it may have been due to the presence of air currents set up by the difference in temperature of the bare ground and the grass-covered areas.

Regardless of the foregoing results it seems that for a clear, calm night, less artificial heat is needed to protect vegetation over an open ground as compared with vegetation that is located over ground

which is covered with a thick mat of grass or similar growth. This may be true only when the ground is carrying a maximum of heat as in the early fall; however, the same should be true when the night was preceded by a day or more of sunshine. If the bare ground is exposed it will absorb the heat during the day and release it at night. When plants cover most of the ground they reflect or absorb the sun's heat to a limited extent allowing little to reach the ground. During the night the plants lose their heat rapidly since they are good radiators and because their heat capacity is limited. Thick, low-growing vegetation would also prevent the ground's heat from reaching vegetation which would be growing above it.

The reasoning above is supported by results of an experiment made in September on tomatoes that were growing in rows. The ground was practically free of weeds and the tomatoes were comparatively short and were spread out in such a way that a maximum of the ground was exposed. The night was clear and ideal for radiation. On this particular night the vegetation started freezing from the top and was not frozen near the ground. This is in contrast to all the tests performed over grassland, where the results showed that freezing started at the ground level and progressed upward. The exposed ground plays an important part in causing this complete reversal in results.

GENERAL SUMMARY

The problem of adapting infrared radiant energy to a method for frost control is complicated by the variance in weather conditions. The type of vegetation coupled with the topographical surroundings and the extent of associated vegetation are also important factors.

A review of the conditions and results of the three experiments are as follows: Experiment I was made when the minimum surrounding air temperature was 26.4° F. The normal temperature inversion would give the air temperature at 1-foot elevation as approximately 30° F. A check of the control plant (Figs. 5 and 6) indicates that freezing damage was done to the coleus plant at this elevation. The plant was damaged to a height of 16 inches. The plants were exposed for 8 hours, and based on known plant-temperature relationships, it would be reasonable to assume that the plant temperature was 8 to 10° F. lower than the surrounding air. Under those conditions, the coleus plants were protected in the area between the radiation units at a distance of 90 feet from the units.

Experiment II indicated that coleus plants will not freeze when the surrounding air temperature is 29.4° F. if the sky is slightly overcast and accompanied by a 10-m.p.h. wind. Under these conditions the surrounding air temperature would approximate the plant temperature owing to the reduced radiation loss and the higher film coefficient for heat transfer.

This experiment also indicated that the radiation unit operating at 1,500° F. was much more efficient than old style units which operated at about 1,000° F.

Experiment III was preceded by several days of sub-freezing weather low enough to have frozen the ground surface. On the day preceding the experiment, the air temperature ranged from 36° to 40° F. Under these conditions plants froze within 45 feet of the units when the surrounding air temperature was 29° F. at the 2-foot elevation. This was accompanied by a ground level temperature of 17° F. Figures 13 and 14 give evidence that open ground reduced the need for artificial heat.

These experiments point out the possible variable conditions of the air temperature within a few feet of the ground and that the surrounding air temperature is not an accurate indication of plant temperature under conditions favoring radiation type frosts.

The results of Experiment I should be given primary consideration since the prevailing weather conditions and the time of year chosen make these conditions representative of those under which artificial protection would most likely be needed. The positive protection obtained in this experiment indicates the possibilities of radiant energy as a practical means for frost control. The limitations, as to effectiveness of this method, will be determined by weather conditions as well as the type of vegetation to be protected and its surroundings.

Type AA unit, owing to its low cost of construction, offers possibilities of being a practical unit for manufacture and distribution commercially. However, before this is attempted on a large scale, further tests should be made, under as many varying conditions as feasible, to fully establish its limits as a practical apparatus for frost control. There will be conditions under which only partial protection will be afforded. The extent of the protection, the value of the crop saved, and the cost of the operation, will be the determining factors as to when and where it will be a profitable method of frost protection for farmers.

BULLETIN REVIEWS

SPECIAL BULLETIN 341

Price Difference Among Markets for Michigan Slaughter Hogs

Stark, D. H. and Madnick, M.

A comparison of the Buffalo, Detroit and Chicago markets from the viewpoint of services rendered and prices paid. (37 pp., 6 tables, 6 figs.)

SPECIAL BULLETIN 343

The Grain Storage Situation in Michigan

Motts, G. N.

This bulletin presents an inventory of the facilities for the commercial storage of grain in Michigan, compared with figures on grain production and the need for storage at different periods of the year within the same area. Some suggestions and recommendations are made for making the best use of available facilities. (58 pp., 19 tables, 19 figs.)

CIRCULAR BULLETIN 206

Apple Juice Preparation and Preservation

Marshall, R. E.

A detailed explanation of the various processes involved in the making of apple juice, its blending, clarification and preservation. Suggestions are given on processing plant layout. It is written primarily for the commercial processor. (68 pp., 2 tables, 31 figs.)

CIRCULAR BULLETIN 207

The Role of Minerals in the Dairy Ration

Huffman, C. F.

This bulletin presents in popular form information on the place of supplemental mineral feeds in the ration of dairy cows that are fed on Michigan-raised grains and forage. Cobalt deficiency is rather common in Michigan; phosphorus and iodine deficiency are of less frequent occurrence. (19 pp., 10 figs.)

JOURNAL ARTICLE ABSTRACTS

Soil Management for Potato Production

TYSON, J.

The American Potato Journal. 22 (9): 267-275. 1945. [Journal Article 761 (n. s.) from the Michigan Agricultural Experiment Station]

Potato production following timothy hay that had been fertilized annually with high-nitrogen mixtures was greater than that following either alfalfa, red clover, or alsike clover that had been fertilized with equal amounts of 0-14-6 grade. The yields were higher on the timothy plots fertilized with 10-6-4 than on those that were fertilized with ammonium sulfate supplying an equal amount of nitrogen, although 500 pounds of 4-16-8 fertilizer was applied for the potato crop.

Large applications (800 and 1,200 pounds per acre) of 0-14-6 fertilizer to alfalfa in the rotation resulted only in slight increases in yields of potatoes following alfalfa, the yields being 307.8, 314.6, and 316.5 bushels an acre, respectively, for the 400-, 800-, and 1,200-pound applications. However applications of large amounts of 10-6-4 annually to the timothy hay crop were accompanied by large increases in potato yields following timothy. The yields for no treatment, 400, 800, and 1,200 pounds of 10-6-4 per acre (applied to the hay crop annually) were 276.1, 319.7, 340.2, and 381.2 bushels an acre, respectively.

A rotation of corn, oats, clover, and potatoes in which the clover crop was cut for hay in June and 8 tons of manure per acre applied was more effective in producing potatoes than the same rotation with the clover and rye crop plowed down as green manures. A 3-year rotation of corn, oats seeded to clover, plowed down in spring for potatoes was least effective in producing potatoes. The average yields for four years were 168.5, 142.9, and 114.0 bushels per acre, respectively.

Evaluation of Carotene Content of Fresh and Cooked Spinach

PORTER, T., WHARTON, M. A., AND BENNETT, B. B.

Food Research. 12 (2): 133-141. 1947. [Journal Article 774 (n. s.) from the Michigan Agricultural Experiment Station]

In the home cooking of spinach there is often an apparent increase in carotene content over the amounts present in the raw material. This is explained as not being an actual increase but is due to the difference in the solid contents of the fresh and cooked products. Including the solids from the cooking water in the total solids of the cooked spinach accounted for only a portion of the difference.

Alternaria Blight and Seed Infection, a Cause of Low Germination in Certain Radish Seed Crops

McLEAN, D. M.

Jour. Agr. Res. 75 (2): 71-79. 1947. [Journal Article 820 (n. s.) from the Michigan Agricultural Experiment Station]

Low germination of certain radish seed crops in Michigan has been found to be associated with infection by *Alternaria.* Four different species of this fungus have been isolated from seed of low germination. Some of this infection takes place in the field before harvesting. Apparently some takes place after threshing and during storage, especially when seeds are stored with a relatively high moisture content. It is suggested that thorough curing of the seed followed by dry storage, is one of the most practicable control measures.

A New Electrical Resistance Thermometer for Soils

BOUYOUCOS, G. J.

Soil Science. 63 (4): 291-298. 1947. [Journal Article 836 (n. s.) from the Michigan Agricultural Experiment Station]

A new liquid electrical resistance thermometer has been developed for measuring soil temperature. It has a range from about $-20°$ to about $132°$ F. The liquid is contained in a glass vial fitted with platinum electrodes. The electrodes are connected to wire leads of any desired length, and the joints are permanently insulated with a special compound. The electrical resistance rises with the decrease of temperature. The electrical resistance is measured in a special Wheatstone bridge that has a range from 0 to 5,000,000 ohms. The thermometer is simple, convenient, and reliable for measuring the soil temperature at various depths.

Pullorum Disease Studies in Turkeys. I. Antibody Production Following Intravenous and Oral Infection, Relative Value of Tube and Whole-Blood Plate Agglutination Tests, Pen Contagion and Duration of Carrier State

CORPRON, R., BIVINS, J. A., AND STAFSETH, H. J.

Poultry Science. 26 (4): 340-350. 1947. [Journal Article 849 (n. s.) from the Michigan Agricultural Experiment Station]

This work was undertaken with the hope of supplying answers to the following questions: (1) How soon after intravenous and oral administration of living *Salmonella pullorum* cultures can antibodies be detected? (2) How much does the antibody titer vary during the course of infection? (3) How long does appreciable antibody production continue? (4) What is the relative value of the standard tube and the whole-blood plate agglutination tests? (5) Does pullorum disease spread among adult turkeys by pen contact and (6) How long may the pullorum carrier state continue? The results were as follows: Agglutinins were

detected by the tube test 3 days after intravenous injection of S. *pullorum* but not until 5 days with the whole-blood antigen. The maximum titers of intravenously injected and orally infected birds occurred on about the ninth day, after which the titer decreased in fluctuating descent. The tube agglutination test was found to be more sensitive and more consistent in reaction than the whole-blood plate agglutination test for the detection of agglutinins in the serum of turkeys infected with S. *pullorum*. The tube test gave positive reactions earlier, and, after the height of the titer had passed, revealed positive sera which were negative to the whole-blood antigens. The K47 antigen (BAI experimental) was a little more than half as effective in detecting birds of low titer or in the early and late stages of infection as was the tube test. Comparing the results of the plate test (antigen K47) with those of the 1/25 serum-antigen dilution of the tube test, the authors found that 220 tests agreed and 71 or 24.4 percent disagreed. Similarly, comparing the results of the plate test and the 1/100 dilution of the tube test, 250 tests agreed and 41 or 14 percent disagreed. Throughout the 8-month investigational period, zones of inhibition were observed in the tubes containing the greatest concentrations of sera from infected birds. These were not eliminated by increasing the concentration of antigen three-fold nor by heating the sera for varying lengths of time at temperatures of 46°, 56°, and 60° C. The data suggest that some specimens of sera that give a weak or doubtful reaction in a 1/25 dilution may be positive if tested in a 1/100 dilution. At the end of the 221-day period, four of the five birds (80 percent) remaining in the intravenously infected group were found to harbor S. *pullorum*, while only three of the seven (42.85 percent) orally infected group were still found to be carriers. S. *pullorum* was frequently recovered from the duodenum pancreas section. The controls probably did not become permanently infected nor did they develop a constant, appreciable agglutination titer as a result of pen contact with infected birds. They were less susceptible to oral infection than were their flockmates originally.

Improvements in the Plaster of Paris Absorption Block Electrical Resistance Method for Measuring Soil Moisture Under Field Conditions

BOUYOUCOS, G. J. AND MICK, A. H.

Soil Science. 63 (6): 455-465. 1947. [Journal Article 850 (n. s.) from the Michigan Agricultural Experiment Station]

The electrical resistance technique of obtaining a continuous measure of soil moisture *in situ* under field conditions by means of a plaster of paris absorption block is discussed in the light of additional knowledge and experience gained since the inception of the method in 1940. Fundamental considerations of the characteristics of this technique reveal that for most practical purposes standard absorption blocks need not be calibrated. Resistance readings may be directly interpreted in terms of available soil water; in all soils the percentage of available water is approximately the same for any given resistance value.

The maximum longevity of absorption blocks operating continuously in the field may exceed 5 years in a relatively dry environment. A minimum life of one season is found in waterlogged organic soils.

The special resistance bridge has been improved, and a new commercial model is presented and described.

The advantages of the method are summarized.

Milk Studies. I. Some Vitamins and Trace Elements Found in the Colostrum of the Dairy Cow, Beef Cow and Swine

LUECKE, R. W., DUNCAN, C. W., AND ELY, R. E.

Archives of Biochem. 13 (2): 277-282. 1947. [Journal Article 860 (n. s.) from the Michigan Agricultural Experiment Station]

No marked breed difference was found in the iron, copper, and cobalt content of colostrum milk of the Jersey and Holstein dairy cow. The concentrations of these minerals in the colostrum of the beef cow were essentially the same as the values obtained for the dairy cow.

The carotene and vitamin A content of colostrum from the Jersey cow averaged 347 and 401 γ/100 ml. while the corresponding values for Holstein colostrum were 100 and 52 γ/100 ml. The concentration of these constituents in the colostrum of the beef cows were 129 and 145 γ/100 ml., whereas, swine colostrum contained only 24 and 60 γ of carotene and vitamin A/100 ml.

The colostrum of the sow is significantly lower in riboflavin and pantothenic acid, but markedly higher in nicotinic acid than either the dairy or the beef cow. The thiamine content of sow colostrum is similar to beef cow and Holstein colostrum but lower than Jersey colostrum.

Determination of Unmet Need for Medical Attention Among Michigan Farm Families

HOFFER, C. R., AND SCHULER, E. A. (IN COOPERATION WITH ROSALIE NELIGH, AND THOMAS ROBINSON, UNIVERSITY OF MICHIGAN)

Jour. Mich. St. Med. Soc. 46: 443-446. 1947. [Journal Article 864 (n. s.) from the Michigan Agricultural Experiment Station]

There is a lack of reasonably accurate information which will show the extent of need for medical care among rural people. Likewise, it is desirable to know to what extent such needs are being met. The present article describes first, a method and second, an experiment to determine the validity of that method, designed to measure the need for medical attention among rural people.

The essential characteristic of the method is a medical needs schedule consisting of a list of 27 questions regarding symptoms about which a physician would ordinarily ask a patient in taking a medical history. Though these symptoms were selected in cooperation with medical physicians the questions were worded so that a person without medical training, if properly instructed and supervised, could obtain the desired information. By use of appropriate symbols a record was made of the way positive symptoms were treated. Three ways are possible: (1) no treatment, or home remedies only; (2) treatment by a non-medical physician; (3) treatment by a medical physician. Because precise evaluation of this approach was lacking, it seemed wise to validate the data obtained with the medical needs schedule. Validation was accomplished by having a random sample of approximately every sixth family among the 306 families interviewed with the schedule come to a clinic to receive a medical examination. The examination was

made by a medical physician and included a chest X-ray, a blood test for syphilis, and an analysis of a specimen of urine for albumen and sugar. The results showed that in 8 out of 10 cases there was agreement regarding the need for medical attention between the findings of the medical examination and data contained in the medical needs schedule. The correspondence between the two sets of data is so close that this method can be used to establish a reasonably reliable measure of unmet needs for medical attention among farm families.

A Comparison of the Glass Electrode and Indicator Methods for Determining the pH of Organic Soils and Effect of Time, Soil-Water Ratio, and Air-Drying on Glass Electrode Results

DAVIS, J. F. AND LAWTON, K.

Jour. Amer. Soc. Agron. 39 (8): 719-723. 1947. [Journal Article 875 (n. s.) from the Michigan Agricultural Experiment Station]

A comparison of glass electrode and indicator methods for determining the pH of muck soil was made on 50 samples collected at random from widely scattered areas in Michigan.

Data obtained indicate a close agreement between pH readings obtained by the indicator and glass electrode methods. Owing to the high buffer capacity of the muck, factors of time elapsing between mixing the muck sample with water and subsequent recording of the pH reading, the soil-water ratios used, and air-drying of samples do not materially affect the pH reading of the sample.

An accurate pH reading of muck may be obtained with a glass electrode when a 1:1 soil-water ratio on volume basis is used and after stirring the suspension for 1 minute.

Direct Introduction of Chemical Substances Into Herbaceous Plants

FELBER, I. M.

Science. 106 (No. 2750): 251. 1947. [Journal Article 881 (n. s.) from the Michigan Agricultural Experiment Station]

By using a needle made of fine florist's wire, which is threaded with white mending cotton soaked in a solution of the chemical to be tested, substances can be introduced to any desired part of a plant. This new technique can be employed regardless of the shape and inclination of organs or the nature of their surface. Methods hitherto used such as placing a drop or pellet of the substance on the surface of a leaf blade, are not feasible for application to erect parts or to surfaces of repellent or impermeable character.

Since the exact amount of substance introduced by thread into tissues can be determined, the method is used in studies of the effect of different concentrations of 2,4-D and other growth regulators on plants. Furthermore, the pH of intact plant tissue can be measured in the growing plant by using threads impregnated with indicator solutions. Many other kinds of microchemical tests can be carried out directly on various organs of the living plant.

The simple device opens many new possibilities in plant research which may lead to a better understanding of the fundamental mechanism of growth.

Medical Needs of the Rural Population in Michigan

HOFFER, C. R.

Rural Sociology. 12: 162-168. 1947. [Journal Article 882 (n. s.) from the Michigan Agricultural Experiment Station]

A survey to determine need for medical attention among 306 scientifically selected Michigan farm families in Cheboygan, Kent and Shiawassee counties showed that 47.9 percent of the 1,219 persons included in the sample had one or more symptoms which should receive medical attention. Among the 1,219 there were 314 individuals (27.7 percent of the total) who had one or more positive symptoms and had not seen a medical physician about them. The need for medical attention increased with the age of the population and with a decline in the gross income of the family. Need in this connection was defined as the presence of one or more of a list of 27 symptoms which had been selected in cooperation with medical physicians and validated by a medical examination of a sample of the families interviewed.

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CONTENTS

(Continued on Next Page)

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: (1) progress reports on long-term major research projects; (2) final reports on short-term projects and (3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

CONTENTS

(Continued from Outside Front Cover)

SELECTIVE CONTROL OF CRABGRASS (*Digitaria* Sp.)[1]

By B. H. GRIGSBY
SECTIONS OF BOTANY AND PLANT PATHOLOGY

DURING the course of certain investigations in 1946 of the effects of solvents on carrot plants, it was observed that some of the materials under test caused injury to small seedlings of crabgrass. This observation led to further work in the search for a compound, or a mixture, which might be effective as a control measure for crabgrass.

Two formulations, L-2687 and L-2988, in greenhouse tests, gave satisfactory control and were tested on lawn plots in the fall of 1946. Young crabgrass seedlings, in an area where other grasses had been destroyed by weed growth, were sprayed with both preparations and were killed within a period of 10 days. In September 1946, lawn plots in which a heavy growth of crabgrass was present, were sprayed. The grass plants were large and flower spikes were already present. Ten days after treatment, all crabgrass was dead, but a few plants of Kentucky bluegrass and quack grass appeared to be uninjured.

Further trials were made is greenhouse flats during the winter of 1946-47. These tests were made to determine the tolerance of annual and perennial plants of the grass group to these chemicals. Flats of commercial lawn grass mixtures were sprayed with the two compounds when the grass seedlings were 2-3 inches in height and no injury was observed. These flats did not develop any crabgrass seedlings but two repeat applications were made at 4-week intervals. The rate of application at each spraying was sufficient to wet all the leaves of the grass plants and was in excess of 100 gallons per acre. None of the grasses were killed but there seemed to be a dwarfing effect upon certain types of grasses in the mixture.

Samples of pure grass seed[2] and cereal grains were obtained and planted in rows in soil containing crabgrass seeds. When the grass seedlings were 3 inches tall, two flats were sprayed with formulation

[1]The work reported here was made possible by a grant from the Standard Oil Company of Indiana.
[2]Supplied by the O. M. Scott and Sons, Company.

ARTICLE 30-47

TABLE 1—*Response of certain grasses and cereals to the petroleum base compounds L-2687 and L-2988*

Grasses	L-2687	L-2988
Barley	Killed	Killed
Bent grass	No effect	No effect
Bluegrass, Kentucky	No effect	No effect
Bluegrass, Canadian	No effect	No effect
Brome	Slight red color in leaf sheath	No effect
Corn	Killed in 4 days	Killed in 4 days
Fescue, Chewings'	No effect	No effect
Orchard grass	No effect	No effect
Ryegrass, domestic	Red sheaths	Red sheaths
Red top	Slight stunting	No effect
Sudan grass	Killed	Killed
Wheat	Killed	Killed
Timothy	No effect	No effect

L-2687 at concentrations of 50 and 75 gallons per acre, and two flats were sprayed with formulation L-2988 at concentrations of 50 and 75 gallons per acre. Two other flats were used as checks. The types of grasses used and results obtained are shown in Table 1.

In order to determine the quantity of the compound required to kill crabgrass seedlings, applications at the rates of 25, 50, 75 and 100 gallons an acre were made on plots containing pure stands of crabgrass, 50 plants per flat, at the 3- to 4-leaf stage of growth. A satisfactory kill was obtained at the 75- and 100-gallon rates and no regrowth of sprayed plants occurred in these flats. At the 50-gallon rate, all plants died to the ground level, but weak growth was observed at the base of five plants. At the 25-gallon rate, growth was stopped, but the base of the plants remained alive and regrowth occurred in 2-3 weeks. A second application, 50 gallons an acre, killed all these plants. The effect of the 75-gallon rate of application is shown in Fig. 1.

In July 1947, applications of both formulations were made on crabgrass seedlings in a field which had been plowed but not seeded to any crop. A heavy growth of grass, pigweed, purslane and jimson weed was present in this area. A single application of the petroleum products destroyed the grass seedlings but did not kill any of the broad-leaved weeds.

During July and August, further tests of the petroleum products

Fig. 1. Effects of L-2687 upon crabgrass. Flat on left sprayed at the rate of 75 gallons an acre, flat on right untreated. Carrots and broad-leaved weeds were not affected by spray treatment.

were made on lawn areas that were infested with crabgrass. The lawn areas were mostly pure stands of Kentucky bluegrass but one test area consisted of 25 percent bluegrass and 75 percent Bermuda grass. The rate of application was 1 quart per 100 square feet. Crabgrass plants at this season were well developed, tillered, and the clumps were 3-6 inches in diameter. In July, the temperature was mild, soil moisture abundant, and a complete kill of crabgrass was obtained in 5-8 days. Bluegrass showed no effects from the spraying, but Bermuda grass developed a slight reddish coloration. This color change, however, was not associated with the death of any leaves.

In the series of plots sprayed during August, when soil was dry and a period of high temperatures and no rainfall prevailed, the same rate of applications gave a rapid kill of crabgrass. It was observed, however, that under these conditions, some injury to the bluegrass did occur. In September, rainfall and lower temperatures brought about a full recovery of the lawn grasses.

Small scale sprayings, at a rate sufficient to wet the foliage, were

made on a number of other grasses and crop plants. Pigeon grass, fox tail, tickle grass, and downy brome grass were killed at any stage of growth by both compounds. Annual bluegrass, quack grass, and stink grass were not affected by either. Beans, field peas, onions, sugar beets, peppermint, gladiolus, and cotton were not affected by direct applications of these petroleum compounds.

During the course of these tests, it was observed that both formulations were toxic to most annual grasses, but the speed of action was somewhat different. Formula L-2687 was more rapid in action and in hot dry weather caused more injury to lawn grasses. L-2988, while slower in taking effect, was about equally effective in killing crabgrass and caused less injury to desirable grasses under unfavorable conditions.

The toxic effects upon crabgrass and other susceptible plants, followed a definite pattern. No effects were visible for a period of 24-48 hours, but later the sprayed plants developed a slight bronzed appearance which changed to a bright purple color in the blade and sheath. These colored plants ceased to grow and, at the end of 5-8 days, began to turn yellow; the leaves died and the stems appeared soft and finally became brown and dry. In the corn plant, the purple color developed in 48 hours, the stems became soft and collapsed, and death occurred within 4 days.

Further studies of the mode of action of these materials are under way, but these observations indicate that some kind of chronic injury occurs in annual grasses which leads to the death of sprayed plants. The characteristic color changes indicate that a disturbance in the translocation of carbohydrate materials occurs and the production of anthocyanin pigment is stimulated. This color change is most pronounced under cool conditions and may not be observed at all in hot dry weather. The effects observed cannot be explained on the basis of an accumulation of oily residue, because both formulations are highly volatile compounds and sprayed plants soon become dry and show no evidence of the accumulation of oil.

The results reported here are from trials under limited climatic conditions, but they indicate that the two compounds possibly have a highly specific toxicity to annual grasses. Similar results in other areas, where different climatic conditions prevail, would establish these materials as useful selective control agents for crabgrass in lawns, turf, golf greens, and in certain crops. This report is given

in order to secure trials under a variety of conditions, the results of which should make it possible to formulate suggestions for the use of the two products as selective herbicides for the control of crabgrass in turf and crop plants.

It is expected that the materials will be available only in small experimental quantities for the 1948 season and for that reason, no suggestions, in regard to dosage nor method of application, are made for the use of home owners or other possible users of the products. The materials offer considerable promise, but further trials are needed and will be made in 1948.

EFFICIENCY IN THE USE OF FERTILIZERS FOR CORN

By L. S. ROBERTSON and R. L. COOK
SECTION OF SOIL SCIENCE

THE DEMAND for fertilizer in Michigan in 1948 will again exceed the supply. For that reason it is doubly imperative that fertilizers be applied for the crops which are most responsive and that methods of application be those most likely to result in the greatest response from a given quantity of fertilizer.

When the supply of fertilizer is equal to the demand, one feels free to recommend the use of as much as economy will permit and for any crop for which there is reasonable assurance that the money expended will be returned. At such a time it may be desirable to recommend fertilizer for some crops which on the average cannot be expected to respond to the fertilizer more than enough to pay the extra expense, since there is always some residual benefit from such an application. On the other hand, the use of fertilizer this year on crops which may not be expected to respond markedly to the treatment may mean that it will be necessary to plant a more responsive crop without fertilizer.

The data obtained from fertilizer and rotation studies on a Brookston clay loam soil in Saginaw County reveal clearly that crops vary in the degree to which they respond to fertilizer. Over a period of 14 years, oats, wheat, alfalfa, and corn have been raised in that sequence, all crops having appeared each year. Several fertilizer analyses have been studied, but the results from 4-16-8 are typical. The oats received 150 pounds per acre, and the yield increase was from 63.6 to 70.2 bushels per acre. Wheat received 250 pounds of fertilizer and yields were increased, as a result, from 25.5 to 33.9 bushels, an increase of 8.4 bushels as compared with 6.3 bushels of oats. Thus, the fertilizer was used more profitably on the wheat than on the oats. Alfalfa followed the wheat without additional fertilizer. The average increase in yield of alfalfa as a result of the fertilizer was 0.71 ton per acre. It has always paid rather well to use extra fertilizer on

ARTICLE 30-48

the crop which is to serve as a nurse crop for alfalfa. Corn has received, in this 14-year experiment, fertilizer at variable rates ranging from 100 to 250 pounds per acre. Most of the applications were at the rate of 100 pounds per acre. The average yield for the 14 years has been 53.7 bushels an acre without fertilizer and 53.2 bushels where fertilized with 4-16-8. To show that it has mattered little what analysis was used so far as corn was concerned, the average yields for six analyses are reported in Table 1. The fertilizer has been applied for corn through the conventional corn planter. Surely these data furnish no evidence to justify a recommendation for the use of fertilizer on corn in 1948.

During the past 20 years over 200 experiments dealing with the fertilization of corn have been conducted on many soil types in 30 counties. In some cases, substantial increases in yields were obtained, but in the majority of the tests the fertilizer did not appreciably increase yields. On some fields, increases in yield were obtained one year but not the next. Because the number of cases of increased yields as a result of fertilizer application has been small and because the results have been inconsistent, the following statement appears in the current issue of the fertilizer recommendation bulletin published by the Michigan State College Extension Service.* "Fertilizer applied with the planter for corn hastens early growth, but usually does not increase yield of grain. Apply fertilizer liberally to small grains, legumes, and other crops preceding corn in the rotation."

In 1941 another experiment on corn fertilization was initiated on the same farm from which came the data in Table 1. It had been observed for several years that corn yielded best when it followed an alfalfa crop. The thought that perhaps it would be possible to fer-

TABLE 1—*Effect of fertilizers on corn yields in an alfalfa, corn, oats, wheat rotation**

Fertilizer analysis	Bushels of corn per acre
0–16–0	53.9
4–16–0	53.5
0–16–8	56.3
4–16–8	53.2
4–16–4	54.3
4–12–4	51.6
Check	53.7

*Average of 14 years data. The soil is a Brookston sandy clay loam. The corn is fertilized at the rate of 100 pounds per acre. The fertilizer is applied with a conventional type of corn planter. The oats and wheat receive 150 and 250 pounds per acre respectively. The alfalfa is not fertilized.

*Extension Bulletin 159.

TABLE 2—*Effect of fertilizing corn indirectly, by topdressing the preceding alfalfa crop with fertilizer**

Treatment	Bushels of corn per acre
1. 1000 pounds 0-12-12 topdressed on alfalfa 125 pounds 4-16-8 in corn row at planting time	50.9
2. Alfalfa not topdressed 125 pounds 4-16-8 in corn row at planting time	49.2
3. 1000 pounds 0-12-12 topdressed on alfalfa Corn not fertilized at planting time	50.4
4. Alfalfa not fertilized Corn not fertilized at planting time	49.7

*Average of 6 years. The corn fertilized at planting time with conventional type planter. This rotation is a corn, bean, barley, alfalfa, alfalfa rotation. The alfalfa is topdressed after the first cutting of the second harvest year. The beans and barley are fertilized with 300 pounds of 0-14-7 and 300 pounds of 4-16-8, respectively.

tilize the alfalfa crop heavily and obtain higher corn yields as a result of the fertilized alfalfa lead to this experiment. The results presented in Table 2 show conclusively that this is not a good way to apply fertilizer for corn.

From the data shown in tables 1 and 2, one might conclude that this land is in such a high state of fertility that fertilizers do no good. Or one might conclude that the variety of corn grown on these plots is not responsive to fertilizer. That this is not the case is demonstrated by the results of the third set of experiments on this same farm.

In this experiment a high-nitrogen fertilizer was plowed down for the corn. The consistency of increased yields is apparent (Table 3),

TABLE 3—*Effect of fertilizer plowed down on corn yields in a corn, corn, soybean, oat, timothy-clover rotation**

Treatments**	Bushels of corn per acre	
	First year	Second year
1. No fertilizer	47.3	35.9
2. Plow down for each corn crop	61.5	51.1
3. Plow down for second corn crop only	46.0	50.4
4. Plow down for each corn crop and planting time application for each crop	61.8	49.2
5. Plow down for second corn crop only and planting time application for each crop	44.4	51.6

*Three-year averages. The soybeans and oats are fertilized with 100 and 300 pounds of 0-14-7, respectively.

**1000 pounds of 8-8-8 is plowed down and 125 pounds of 4-16-8 is applied at planting time with a conventional type of planter.

thus showing that the natural soil fertility was not responsible for lack of response in the earlier experiments and that the variety of corn used on all of these plots does respond to fertilization. The data indicate that in a soil-depleting rotation, such as is practiced in this experiment, it is possible to increase corn yields considerably by plowing down fertilizer, but a summary of all the plow-down experiments conducted over the lower part of the state during the past 5 years show little reason for recommending this practice. Perhaps the increases in yield which have resulted in this particular case are the result of the much greater need for nitrogen in this soil-depleting rotation which is not a rotation commonly used in Michigan. It should be stated at this time that the plow-down attachment affords an easy and rapid method for applying large amounts of fertilizer when one wishes to build up rapidly the reserve fertility of his soil. The data reported in Table 3 show another case where fertilizer applied with a conventional type corn planter did not increase the corn grain yields.

In 1945 a new approach was taken on the corn fertilization problem. It had been shown in previous experiments that fertilizer for beans, peas, and sugar beets should be placed to the side of and below the seed. Most of the fertilizer attachments for corn planters on the market today place the fertilizer in two bands either level with or above the seed. That this placement is not good is indicated by the fact that in most cases higher yields have not resulted from fertilizer applications with these machines.

Accordingly, experiments were started in which fertilizers were placed in bands at different depths below the seed, and slightly to one side of it. As comparisons, treatments were also included in which the fertilizers were plowed under and applied with the conventional planter. The machines for placing the fertilizer at different depths below the seed was constructed by the Division of Farm Power and Machinery of the Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. There have been nine experiments in three counties on five soil types conducted to date. The results are promising enough to indicate that if the fertilizer is placed in a similar fashion to that recommended for sugar beets and beans, a consistent increase in yield from fertilizer can be expected.

One of the experiments on fertilizer placement was located on the same farm and in the same 40-acre area with the experiments just reported in tables 1, 2 and 3. The data shown in Table 4 are the

TABLE 4—*Effect of fertilizer placement on corn yields in 1947**

Treatment	Bushels of corn per acre**
1. No fertilizer	29.1
2. Conventional planter—125 pounds of 3-12-12	35.4
3. Conventional planter—400 pounds of 3-12-12	35.2
Experimental planter—400 pounds of 3-12-12.	
4. Fertilizer level with seed on both sides	35.9
5. Fertilizer level with seed on one side	35.9
6. Fertilizer 2 inches below seed on both sides	40.3
7. Fertilizer 2 inches below seed on one side	37.8
8. Fertilizer 4 inches below seed on one side	41.6
9. Fertilizer 6 inches below seed on one side	35.1
Experimental plantor—800 pounds of 3-12-12	
10. Fertilizer 6 inches below seed on one side	42.1
Fertilizer plowed down.	
11. 800 pounds of 8-8-8	34.1
12. 675 pounds of 8-8-8 and 125 pounds of 3-12-12 with a conventional planter at planting time	40.2
13. 675 pounds of 3-12-12 and 125 pounds of 3-12-12 with a conventional planter at planting time	30.7

*Second-year corn in a corn, corn, oats, wheat, alfalfa rotation.
**Difference required for significance at the 5-percent level—7.0 bushels.

results of this experiment. Since these results are for only one year, it is not safe to draw definite conclusions. More investigation on this farm and at other locations will make it possible to make definite recommendations.

The general conclusions to date from these fertilizer placement investigations are: 1) The placement of fertilizer with the conventional corn planter does not produce consistently significant increases in yield. 2) Fertilizer placed in bands to the side of and below the seed gives promise of producing significant yield increases. 3) To date no specific depth can be recommended except that the fertilizer should be placed below the seed. 4) Fertilizer plowed down does not give as good results as does fertilizer placed below the seed at planting time. 5) Fertilizer placed in one band to the side of the seed is as effective as is fertilizer placed in bands on each side of the seed.

SUMMARY

The demand for fertilizer in Michigan in 1948 will exceed the supply. For that reason it is doubly important that fertilizers be ap-

plied properly and for the crops in the rotation which are most likely to respond.

Experiments have shown that sugar beets, beans, wheat, oats and alfalfa are more responsive than corn to applications of commercial fertilizer. The inconsistency in the results obtained from experiments with corn have led to numerous experiments concerning kinds of fertilizer and methods of application for this crop.

Corn has not responded to large quantities of phosphate and potash fertilizer applied on the alfalfa during the summer preceding the plowing of the land for corn. In general, the application of fertilizer through the conventional corn planter has not significantly increased corn yields. A fertilizer high in nitrogen (8-8-8) has, over a 3-year period, caused significant increases in corn yields in a rotation which exhausts the soil nitrogen supply. Consistent and significant increases in corn yields have been obtained when the fertilizer has been placed in bands below and to the side of the seed.

DEHYDRATED POTATOES FOR SWINE

By W. N. McMILLEN, G. A. BROWN and R. W. LUECKE
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POTATOES may be dried into meal, flour or flakes containing about 10 percent moisture. In 1944 the United States government in cooperation with the Monitor Sugar Company of Bay City, Michigan, and other sugar and flour mills dehydrated potatoes for livestock feed as one means of disposing of a surplus.

Ferrin (1) in Minnesota trials during the winter of 1942-43 fed lots of 10 pigs, with an initial weight of 65 pounds, potato meal to replace 20, 30 and 40 percent of the corn. He concludes that 1 pound of potato meal is a satisfactory replacement for 1 pound of corn to an extent of 30 percent of the mixture of the two feeds.

Hughes (2) at the California Station fed potato meal at various levels including 10, 25 and 40 percent of the total diet. When potato meal was included in the ration the same amount of barley was taken out. It was fed with tankage, alfalfa meal, salt and oyster shell flour. He concludes that potato meal can logically be fed at a 25-percent level to pigs of all sizes and ages and that 120-pound pigs handle potato meal more efficiently than 50-pound pigs when 40-percent potato meal is used.

Longwell and Buchanan (3) found that dehydrated potatoes could be used to replace up to one-half the corn for fattening pigs without markedly affecting feed requirements. They used pigs averaging 133 and 96 pounds, initial weight, respectively in two of their experiments. This indicates that older hogs are able to use successfully a larger percentage of potato flakes than pigs of lighter weights.

Potato flakes from the Bay City plant were purchased by the College in 1944 and fed to experimental lots of 12 pigs each in the summers of 1944 and 1945.

The potato flakes used had the following composition: moisture—10.48 percent; protein—7.94 percent; ether extract—0.27 percent; crude fiber—2.85 percent; ash—3.56 percent; and nitrogen-free extract—74.89 percent.

ARTICLE 30-49

EXPERIMENTAL PROCEDURE

On July 6, 1944, 12 pigs were allotted, placed on rape pasture and were started on a ration of 75 percent potato flakes, 23½ percent protein supplement and 1.5 percent mineral. The protein supplement consisted of equal parts of soybean oil meal and meat scraps. The mineral mixture was made up of equal parts of salt, ground limestone and steamed bonemeal. Owing to severe diarrhea and extremely poor gains this lot was discontinued after 4 weeks.

Another group, Lot 2, was started on the same date on a mixture of corn, protein supplement and mineral. The corn and supplement were mixed so that the pigs received approximately 18 percent crude protein up to 90 pounds in weight, 16 percent up to 125 pounds, and 14 percent to the end of the trial. The average ration consumed is shown in Table 1.

A third group, Lot 3, was handled like Lot 2 except that one-half the corn was replaced with potato flakes. The average ration consumed by the pigs is also shown in Table 1.

Owing to the high feed requirement when 42-percent potato flakes were fed in 1944, a ration was fed containing only 30 percent potato flakes in 1945.

On June 12, 1945, a group of 12 pigs (Lot 4) was placed on rape pasture with access to a ration of ground corn and protein supplement fed free-choice.

TABLE 1—*The influence of dehydrated potato flakes as a replacement for a part of the corn when fed to pigs on rape pasture*

Lot number*....	2 1944	3 1944	4 1945	5 1945
Average ration..	Corn —84.0 Supplement—14.5 Mineral — 1.5	Corn —42.0 Potatoes —42.0 Supplement—14.5 Mineral — 1.5	Corn —89.0 Supplement—10.5 Salt — 0.5	Corn —60.0 Potatoes —30.0 Supplement— 9.5 Salt — 0.5
Average initial weight in pounds	65.0	62.0	44.0	43.0
Average final weight in pounds	202.2	196.6	230.8	215.3
Daily gain in pounds.......	1.49	1.43	1.46	1.37
Feed per 100 pounds gain in pounds.......	391.2	478.4	373.9	367 2

*12 pigs in each lot.

Lot 5 was fed under the same conditions and with the same ration as Lot 4 except that one-third of the corn was replaced with potato flakes.

The average ration consumed by lots 4 and 5 is shown in Table 1. Enough salt was mixed with the protein supplement for these two lots so that the pigs received approximately 0.5 percent salt in their feed.

RESULTS AND DISCUSSION

The average daily gains and feed requirements are presented in Table 1. The pigs fed an average of 42 percent potato flakes (Lot 3) gained slightly less and required 18.2 percent more feed per unit of gain than the control pigs in Lot 2. The pigs in Lot 5, while eating an average of 30 percent potato flakes, made only 0.09 pound less daily gain and their feed requirements were as low as that of their corn-fed controls, Lot 4. These data indicate that 42 percent potato flakes is too high a level and that 30 percent can be fed without increasing feed requirements. In both the 1944 and 1945 trials reported here, the pigs receiving potato flakes made lower gains than their controls until they reached a weight of about 120 pounds after which the gains were approximately the same.

SUMMARY

1. Potato flakes are unsatisfactory for growing pigs when used as the only feed other than protein supplement.

2. When potato flakes were fed as 42 percent of the ration to pigs on rape pasture, feed requirements were increased 18.2 percent.

3. When potato flakes replaced 30 percent of the corn in the ration of pigs on rape pasture, the rate of gain and feed requirements were similar to the controls.

4. In these trials the pigs utilized potato flakes to better advantage after reaching a weight of 120 pounds.

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2. Hughes, E. H. Private Communication
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DEGREE OF RIPENESS AT HARVEST AND PEACH QUALITY AFTER HOLDING

By M. E. CRAVENS, JR., and PAULINE PAUL
SECTIONS OF ECONOMICS AND HOME ECONOMICS

AN IMPORTANT problem in the marketing of peaches is the deterioration in peach quality that begins as soon as the peach ripens and continues rather rapidly during the storage after picking. The tree-ripened peach has less life remaining than one picked at an earlier stage. Before tree-ripened peaches can be marketed successfully, it will be necessary to know the rate at which deterioration in quality occurs with ordinary harvesting methods, and the time required to market peaches commercially. A limited study was made of these factors during the 1946 and 1947 seasons by the Sections of Economics and Home Economics.

Seventeen shipments of Michigan peaches were traced during the 1946 season to learn, among other things, the time they took from packing house to consumer. The marketing time of half-bushel cell boxes and bushel containers of peaches ranged from less than 2 days to almost 12 days, averaging about 4½ days. After purchasing the peaches, the consumers did not use all of them at once but were still using them on the average for 3½ days. This means that the average peach picked on September 20, packed and shipped on September 21, would reach the consumer about September 25 or 26 and that the last peach would be used about September 29—nine days after picking.

On September 20, 1947, peaches of three degrees of ripeness were selected to test change in quality during these average marketing times. These peaches were tested by experienced judges for taste and other quality factors. Tests were made on September 22, or 2 days after picking, and on September 24, 26, and 29. Since the major proportion of the Michigan peach crop is handled without refrigeration, these peaches were held at room temperature (about 70° F.). The qualities scored were those considered by the housewife in determining the acceptability of any given lot of peaches.

ARTICLE 30-50

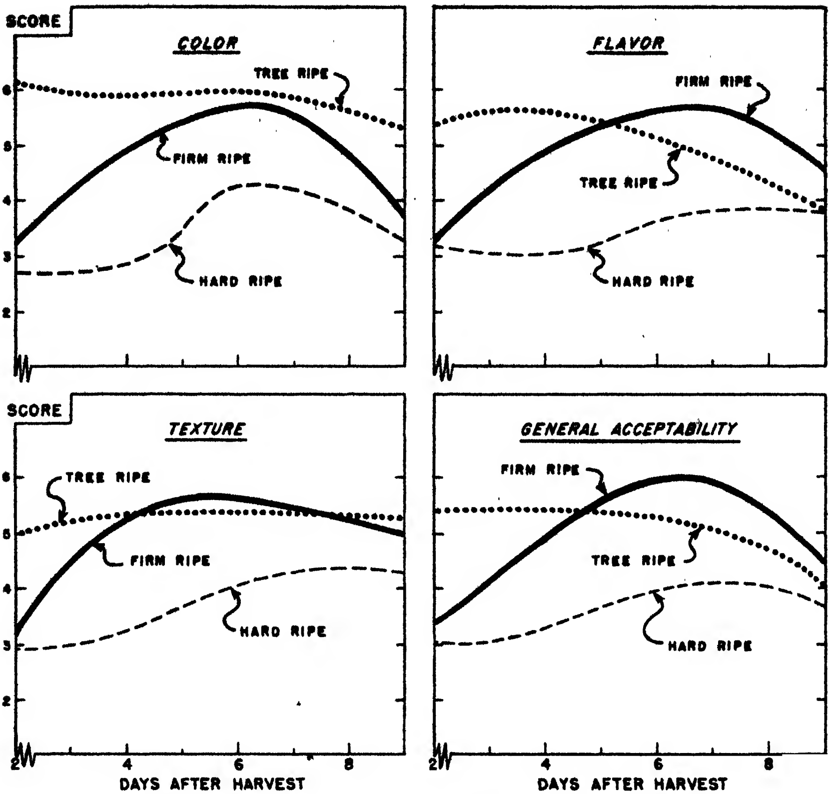

Fig. 1. Effect of holding at room temperature on average scores of quality factors for Elberta peaches packed at different degrees of ripeness (Maximum possible score: 7).*

The results indicated that the tree-ripened peaches were much more acceptable at 2 days after harvest than were the firm-ripe or hard-ripe ones (Fig. 1). At 4 days, the tree-ripened peaches were still slightly more desirable than the firm-ripe peaches. Six days after picking, the firm-ripe peaches were more acceptable than the tree-ripe, and as acceptable as the tree-ripe peaches had been at 2 or 4 days. At 9 days the quality of the firm-ripe peaches was again highest. At no time did the quality of the hard-ripe peaches equal that of either tree-ripe or firm-ripe peaches.

Tables 1 and 2 present data on some of the factors other than

*Scored from sliced peaches.

TABLE 1—*Skin color, incidence of withering and internal browning, and ease of peeling in relation to length of storage of peaches at room temperatures*

Date	Sample	Skin color score*	Withering	Internal browning	Ease of peeling
September 22	tree-ripe	4	none	none	easy
	firm-ripe	2	none	none	difficult
	hard-ripe	1	none	none	very difficult
September 24	tree-ripe	5	none	slight	easy
	firm-ripe	3	none	none	fairly easy
	hard-ripe	2	none	none	difficult
September 26	tree-ripe	5	moderate	slight	easy
	firm-ripe	3	slight	none	easy
	hard-ripe	2	slight	none	easy
September 29	tree-ripe	4	very marked	marked	easy
	firm-ripe	3	marked	slight	easy
	hard-ripe	2	moderate	none	easy

*Skin color scores ranged from 5 for full yellow with considerate red overlay, to 1 for green.

palatability which are important in determining acceptability of peaches. These data confirm, in general, the judges' conclusion that tree-ripe peaches were superior for 4 days after harvest, and firm-ripe peaches were better for storage periods of 6 to 9 days. The firm-ripe peaches did not develop the attractive external color of the tree-ripe peaches, while the hard-ripe peaches were still quite green at the end of the storage period.

This test for one season under the described conditions indicated that the peaches picked at the tree-ripe stage were superior until about the fifth day from harvest after which the quality of the peaches picked firm-ripe was more desirable. It is probable that with temperatures higher or lower than those in the laboratory the rates of change would be different.

The results of this experiment check with sales tests reported by Heckman[1] in St. Paul, Minnesota, where Colorado peaches picked

TABLE 2—*Occurrence of rot in peaches held at room temperatures*

Sample	Total number of peaches in sample	Rotted during storage	
		Number peaches	Percent
Tree-ripe	36	21	58.3
Firm-ripe	34	8	23.5
Hard-ripe	33	5	15.2

[1]John Heckman, "Marketing Colorado Boxed Peaches in the Twin Cities, 1947"; Miscellaneous Report 111, Cooperative Research and Service Division, Farm Credit Administration, Washington, D. C.

at the firm-ripe stage outsold those picked at either tree-ripe or hard-ripe stages.

These results suggest that the marketing of peaches at the tree-ripened stage may result in the supplying of an inferior product to the consumer, if the time interval from harvest to consumption is longer than 5 to 6 days. Altered marketing practices may improve this situation either by shortening the time from harvest to consumption, by introducing storage conditions which will permit holding tree-ripened peaches for longer periods of time, or by promoting the use of firm-ripe peaches for the many conditions where tree-ripe peaches cannot be marketed successfully.

RESULTS OF EXPERIMENTS ON MARKETING RIPER PEACHES

By M. E. CRAVENS, JR., and ARTHUR MAUCH[1]
SECTION OF AGRICULTURAL ECONOMICS

THE WORK at Michigan State College aimed at developing a container to market tree-ripened peaches was begun by T. A. Merrill of the Section of Horticulture in 1942.[2] During 1946 and 1947 the scope of the study has been expanded somewhat, with the sections of Horticulture and Economics cooperating. This is a report of the work by the Section of Economics for these years.

I. PACKAGING

At the outset this problem was considered as primarily one of developing suitable containers for protecting tree-ripened fruit. The years of tests have shown that in addition to containers that will handle tree-ripened fruit there are other and perhaps more difficult problems to be overcome if riper fruit is to become a reality. These other problems will be dealt with in Section II.

[1]Professor Mauch is Extension Specialist in Agricultural Economics.

Professor H. A. Cardinell of the Section of Horticulture read and made valuable suggestions concerning this article.

[2]In 1944 and 1945 Merrill demonstrated that the cell-type container reduced bruising and made the carrying of tree-ripened peaches possible. His experiments were on a limited scale. In 1946, arrangements were made to try the package in the Detroit stores of The Great A. & P. Tea Company on a commercial scale. It developed that the packing houses were unable, for various reasons, to supply the necessary volume of tree-ripened peaches for as large a test of the container as planned for it. The Millburg and Sodus Fruit Exchanges packed the peaches and cooperated in the 1946 project. H. P. Gaston of the Horticulture Department assisted by Winfred Ettesvold of the Economics Department kept the shipping records, supervised shipments and organized the packing operation. In all, about a third of the intended volume was packed. The authors of the present report observed peach sales in Detroit.

Owing to the difficulties in obtaining tree-ripened fruit in volume during 1946, it seemed advisable to study some of the "bottlenecks" to getting tree-ripened fruit in addition to more detailed information concerning the packing of peaches during 1947. With this in view, the A. & P. Tea Company, the Millburg and Sodus Exchanges and the Horticulture and Economics Sections of the Michigan Agricultural Experiment Station agreed on a limited volume test of tree-ripe peach shipments in 1947. Owing to the unusual season, the only special packages of Elberta peaches shipped were about 150 cartons of 4-quart baskets packed 6 baskets to each "master" carton. These were not tree-ripened peaches. As a result, H. A. Cardinell of the Horticulture Department was able to devote almost full time to the observation and study of the stericooling process, a hydrocooling process using a chlorine-type germicidal agent, "Hypo-clor," in a patented hydrocooler called "The FMC Stericooler". He also placed postcards in several hundred containers of peaches. Lawrence Boger, Robert Kramer and the authors of this report were able to collect the ripeness and yield data and limited sales data.

A separate report on the results of the trials of the "stericooler" on peach rots has been prepared by H. A. Cardinell and A. E. Mitchell. It appears on pages 460 to 467 of this issue of the *Quarterly Bulletin* as Article 30-60, "Packing House Trials to Reduce Peach-rot."

ARTICLE 30-51

TABLE 1—*Reasons for preferring peach container as purchased*

Item	Cell box	Wood box*	Bushel basket
	(percent of total)		
Fewer bruises	57	70	60
Less rot	29	15	20
Easier to handle	9	15	....
Other	5	....	20
Total	100	100	100
Number of answers	190	20	5

*2200-inch Michigan box.

Consumer Reaction to Containers

About 400 of the 15,000 postcards placed in containers were returned by peach consumers. This low return was partly due to the fact that many of the peaches were not sold in the original container and the card was designed only for this method of sale.

Consumers logically preferred the container they had purchased, although 98 percent of the cell box purchasers indicated preference for the cell box, and only 82 percent of the purchasers of the tub bushel said they preferred the bushel. The important thing was why they preferred the various containers (Table 1). They were mainly concerned with container qualities that protected the fruit or lessened rot. Over 80 percent of the replies gave these reasons for preferring cell boxes and wooden bushel boxes. Two percent of those purchasing the cell container stated that they did not like it because it was too expensive. The principal dislike stated for the other containers were excessive bruising and waste.

About 60 percent of the buyers of cell containers preferred the ½- to ⅗-bushel unit of purchase, about 35 percent preferred a bushel unit, and another 5 percent a smaller, 4- or 8-quart unit. On the other hand, 16 percent of the purchasers of bushels stated a preference for half-bushel containers.

Reactions to Peaches

Consumers were asked to state the reason for any waste in the peaches they purchased (Table 2). Rots were given by four out of five as the main reason for waste, with most of the remainder blaming worminess.

TABLE 2—*Reasons given by consumers for waste in peaches*

Item	Year 1946	Year 1947	Average
	(percent of total)		
Rot	81	81	81
Worms	16	19	16
Crushed	1	....	1
Too green	1	....	1
Over-ripe	1	....	1
Total	100	100	100
Number replies	156	21	177

In the section for remarks several commented on the peaches. In this section "too green" was the most common complaint, making up about 49 percent of the total remarks in 1947 (Table 3). The next most common complaint was that of excessive rots. One customer in five who answered said that the peaches were satisfactory. These complaints and remarks were of particular interest in a year when rot was as serious as in 1947. In 1946 fewer remarked on the greenness of the peaches.

TABLE 3—*General remarks on peach cards, 1947*

Item	Number	Percent of answers
Too green	20	49
Rots	5	13
Rot before ripen	3	7
Bruised	3	7
Poor flavor	1	2
Wormy	1	2
Good or excellent peaches	8	20
Total	41	100

TABLE 4—*Average days from time peaches were packed to time purchased by consumers and percent waste reported by type of container*

Type of box	Average days from pack to consumer 1946	Average days from pack to consumer 1947	Percent waste 1946	Percent waste 1947
Cell box	3.0	....	1.9	....
Bushel basket	5.8	1.9	4.6	7.5
Bushel box	11.5	6.9	5.2	18.7
4-quart box	....	1.5	....	0.0*

*This may have been due to replacing of spoiled peaches at the retail store.

TABLE 5—*Distance peaches shipped, days from packing house to consumer, and waste in peaches, 1947*

	Dust treatment	
	Average days	Percent waste
Under 400 miles	3.4	20.0
400 miles and over	9.2	16.0

Waste in Peaches

The reported waste in peaches varied from less than 2 percent for peaches from cell boxes in 1946 to about 19 percent for peaches in wood boxes in 1947 (Table 4). It was not believed that the greater waste reported in peaches in the wood box than in tub bushel baskets was significant. Since the number of days during which these peaches were on their way to these consumers was thought to bear some relationship to the development of rots, this time was also reported. However, the fact that the longer hauls were mostly refrigerated, while the shorter ones were not, apparently offsets the disadvantage of the longer time enroute (Table 5).

One of the more interesting differences in the 1947 experimental shipments was the 2-percent waste reported for stericooled as compared with about 18 percent for non-stericooled peaches. This represented 18 replies from consumers in Florida, Texas, Pennsylvania, Illinois and Michigan.

Utilization of Peaches

About 75 to 90 percent of the peaches purchased by consumers in the original container were used for canning (Table 6). The remainder were sliced or eaten fresh.

TABLE 6—*Utilization of peaches purchased in original containers*

Container	1946			1947		
	Sliced or eaten	Canned	Total	Sliced or eaten	Canned	Total
	(percent)			(percent)		
Cell boxes	18	82	100.0	......	......	......
Bushel basket	26	74	100.0	7	93	100.0
Wood box	20	80	100.0	26	74	100.0

Quality Observations in Retail Stores

About 17 percent of the Halehaven and 14 percent of the Elberta peaches observed in retail stores had rots or other major defects that would have hindered retail sales (Table 7). Rots made up 86 percent of the total defects in the Halehaven and 65 percent of the total defects in the Elberta peaches. Over 60 percent of these rots were found at the stem end. Major bruises made up 12 percent of the Halehaven and 28 percent of the Elberta defects. The fewer bruises in the normally easily bruised Halehaven variety than in the Elberta were mainly due to the large proportion of the Halehaven sample that was marketed in cell boxes. Only 1 percent of the defective peaches in cell boxes were bruised whereas from 4 to 37 percent of the peaches in other bulk containers were bruised. This is a good illustration of the effectiveness of the cell box in protecting the fruit. With peaches retailing at 6 to 8 cents a pound, a container that will deliver from 3 to 36 pounds more of undamaged fruit per hundred pounds of fruit shipped to the store is worth a considerable extra cost.

TABLE 7— *Major defects observed in peaches and percentage of peaches defective in experimental shipments and retail stores, 1947**

Item	Cell box	Tub bushel	Wooden box	4-quart basket	All containers
	(percent of defective peaches with each defect)				
Halehaven					
Rots: Stem end	69	25	49	81	54
Other	29	68	23	5	32
Major bruises	1	4	26	12	12
Worminess	1	....	1	2	1
Other defects	....	3	1	....	1
Total	100	100	100	100	100
Number of peaches examined	1440	377	987	300	3104
Percent of peaches defective	12.3	26.3	19.9	14.3	16.6
Elberta					
Rots: Stem end	....	42	41	....	41
Other	....	32	15	....	24
Major bruises	....	19	37	....	28
Worminess	....	5	5	....	5
Other defects	....	2	2	....	2
Total	....	100	100	....	100
Number of peaches examined	....	513	605	....	1,118
Percent of peaches defective	....	17.2	13.1	....	13.8

*Any defect that was adjudged noticeable enough to cause sales resistance was called a major defect.

TABLE 8—*Retail peach sales test, Elberta peaches, 1947*

Method of display	Price per pound (cents)	Pounds sold	Percent of total
Bulk—by pound	6.0	667	52
Box with cellophane window (about 2½ pounds)	6.0	434	34
4-quart basket (about 5 pounds)	7.8	175	14
Total		1,276	100

Retail Sales Test

In 1947 a brief sales test was made on consumer packages. This test was run for two hours daily on four successive days in a large retail food market, with the choices shown (Table 8). The peaches in the bulk display and those in the box with the cellophane window were indentical. Those in the 4-quart basket were of the same variety and grade but were not the same lot of peaches. These baskets were packed at the shipping point, while the other boxes were packed at the retail store.

In this experiment the price per pound was the same for the bulk and the box with the cellophane window, but about 2 cents per pound (30 percent) more for the peaches in the 4-quart basket. The store was located in a high-income section in the Detroit area. The bulk lot outsold the other two combined. However, the fact that customers bought about one pound in packages to each pound from bulk displays indicated a willingness on the part of many to try the package.

The results of this test are not conclusive. They do suggest, however, that it is unsound to put too much faith in the sales appeal of packaged over bulk fruit. Unless the package reduces the price or increases the quality of the fruit for sale, it will probably not appreciably affect sales in the long run.

Produce Managers' Reaction

Produce managers in 36 A. & P. stores submitted information concerning peach sales in 1946. These stores handled 10,623 bushel baskets and 887 cell-type containers, the latter having a capacity of approximately ⅗ bushel. The cell box contains four layers of 24 peaches, or a total of 96 peaches. About one-eighth of the cell-packed peaches were sold by the pound in small lots. In one store all of the

Fig. 1. Packing peaches in the experimental 4-quart basket. It was found that the peaches had to be "placed", in order to insure a full pack that could be shipped successfully in the master carton.

26 cases received were sold in this way. In some stores this method of sale was due to the better condition of the cell-packed peach, and in others due to the consumer resistance to the package.

The total loss, in 30 stores reporting loss, owing to reduction in price or discarding of soiled peaches, amounted to nearly 4 percent of the retail value of the peaches. Estimates indicated that nearly 12 percent of the bushel baskets suffered a mark-down in price due to over-ripeness, bruising, market price changes, or week-end clean

up. Price reductions for the cell box occurred in only some over 4 percent of the cases.

The managers said that the quality of peaches in 1946 was generally good, and most buyers commented that it was the best in years. A few complained of clingstones. Many customers said they would have bought more except for the lack of canning sugar.

Of the 36 managers, 13 reacted very favorably toward the cell-type box, and an additional 14 were favorable toward it with certain reservations. Some said it would take a little time to educate the consumer to its merits. Some added that the fruit should be riper than in the bushel baskets, while a few said a half-bushel box would be "swell," but no more 96-peach or ⅗-bushel containers. A few thought that a cell bushel would be a good seller. Seven managers definitely were dissatisfied with the cell box, and two had no comment.

Each manager was asked if he preferred the bushel basket only. Of course, the seven who were opposed to the cell box preferred the bushel basket only. In addition, five others answered this question in the affirmative. Eight of these 12 said the customers were better satisfied with the conventional package or that there was customer resistance to the cell box. Other reasons mentioned were that a better mass display could be attained and the bushel basket was a better volume getter.

Nineteen produce managers preferred a combination of the bushel basket and the cell box. Four of these liked the cell box because it helps to maintain quality of the peach longer, and another said, "they sell good by the pound," which is another way of saying they were of better quality than those in the baskets. Three stated that the bushel was too large for small families and apartment dwellers, and three others said, "the more variety, the more business." Eight gave no reason for preference for both the cell box and the bushel basket. Five managers did not answer this question.

Following are the comments of one store manager concerning the 1947 experimental packages: "I believe the two-pound package is all right; however, this year, as you know, was not a fair trial. The peaches would not hold up long enough to assure good merchandising. For this package the merchandise must be of the best. Without a doubt the half-bushel cell pack is the very best. Of course, we must have the 4-quart basket also to sell to those wanting more than 2 pounds and less than a half-bushel.

"The peaches received in the western box were in much better condition than the bushel basket peach. They had 'class' or 'distinction' compared with the bushel basket."

Summary and Conclusions on Packaging

In 1946 the cell boxes were retailed at $2.09 and bushel baskets at $2.89. Hence, a premium of about one cent a pound was asked for the former, although in some cases there was little difference in ripeness when packed. The peaches were larger and more uniform in size than those in other containers. Two cell boxes cost about 20 cents more than a bushel basket. In addition, a premium of 10 cents a box was charged for extra packing costs. The packing houses were not set up to handle the cell box efficiently, and only about 10 percent of the peaches woud fill the 2-⅝ inch cells; consequently, though it was expected that up to a thousand cartons would be packaged daily for 10 days, an average of fewer than 300 were packed. Stop-watch studies by H. P. Gaston indicated that peaches can be put up in cell-type containers just as rapidly as they can be packed in bushel baskets or western boxes. Putting up fruit in this way probably will not add to the expense if packing house lines are set up to handle this package and if suitable sizes of cells are available.

The principal value of the cell-type package lies in its ability to carry relatively ripe peaches better than other packages now in common use. The interval between full maturity and heavy loss due to over-ripeness is so short that a large part of Michigan's commercial peach crop is harvested and packed while the fruit is in the "hard ripe" stage. Hard-ripe peaches do not particularly need the protection afforded by the cell-type package; and inasmuch as such packages are relatively expensive and do not display the fruit to good advantage, it is questionable that such packages will come into widespread use as long as peaches move through existing channels of trade and under existing methods.

Advantages of the Cell-Pack

The ability of the cell-pack to protect the fruit from bruising and to aid in preventing spread of brown-rot was not so significant in 1946. That year brown-rot was not a major problem because of the dry season.

No Elberta peaches were shipped in the cell boxes during 1947. Other tests showed that a large part of the rot infection of sound peaches comes from contact with infected ones. This package eliminates the contact between peaches.

Another advantage is that the cell-pack affords small families and apartment dwellers an opportunity to buy less than the bulky, unwieldy bushel basket which is hard to carry and store in the home. Furthermore, peaches will hold quality longer in the individual cells and there is less urgency to process quickly.

Cell boxes are handled easily and stacked efficiently, and carry the weight of the load well if not stacked more than 5 or 6 high. Experience reveals that even when the carton is crushed considerably in the lower tier the fruit shows no visible damage.

Disadvantages of the Cell-Pack

Cell boxes are relatively expensive. They cost about 20-25 cents more per bushel than tub bushel baskets.

The cell box requires sorting of peaches to a size that will fill the cells. Even then there seems to be an excess of paper.

If the fruit is not sufficiently ripe or lacks color, the cell-pack accentuates the lack of color.

Cell boxes do not lend themselves to an attractive mass display such as is possible with the bushel basket. However, this probably could be improved with some experience and with more packages per store.

There is always consumer resistance to a new package. In spite of variation in quality and weight and the high price, however, consumers in general expressed satisfaction with the cell-pack. With quality fruit and consumer education, this resistance can be eliminated. With lower consumer incomes, however, it may be more difficult to attract buyers if a premium price is necessary. This difficulty was reported by produce managers in stores located in low income areas in 1946.

Recommended Improvements

The cell-type package would be improved if the paperboard units which make up a tier of cells were made so that they would cling together more firmly. Many of those supplied this year fell apart as

they were handled. Packers spent considerable time reassembling cell units.

Cell-type packages should be ventilated. Those for use in 1947 were ventilated.

The cell-type package would be better if the cell unit used to protect the fruit in the top layer were re-designed in such a way that it would show the fruit to better advantage.

The cells should be designed to hold small as well as large peaches and the number of cells adjusted to obtain a true half bushel.

II. OTHER FACTORS AFFECTING RIPENESS OF PEACHES MARKETED

This part of the report is a summary of some items of information having a bearing on the problem of marketing ripe peaches, but is not a part of the packaging study. Until more complete data are available on some of these factors, the developing of packages alone will not solve the problem.

Normal Seasonal Peach Price Movements

An analysis of Elberta peach prices at the Benton Harbor Market for the 1938-42 and the 1943-47 seasons shows a very distinct seasonal

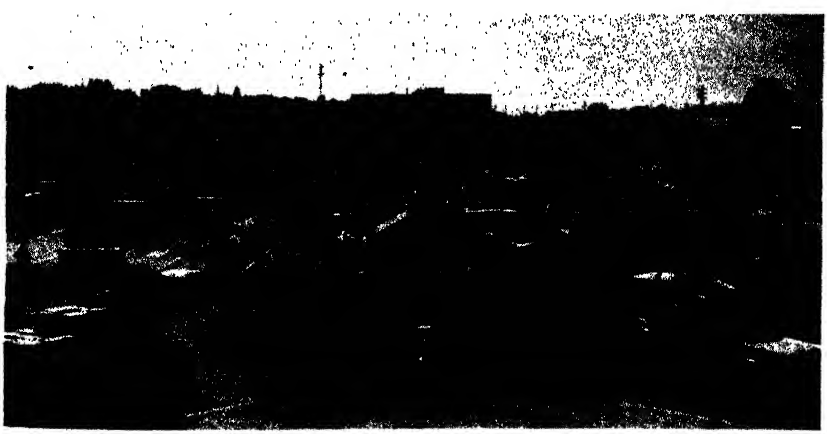

Fig. 2. The Benton Harbor Market over which about 1,293,000 bushels of peaches were sold during the 1947 season. Buyers on this market had their choice of several degrees of ripeness. Most peaches were packed in bushel baskets.

pattern (Fig. 3).[1] Since the 1943-47 period was greatly affected by price controls, more weight has been given to the pattern during the 1938-42 seasons. During this period peach prices rose until about seven marketing days before the peak peach sales through the Benton Harbor Market. Prices then fell until 2 to 4 days after the largest days volume of peach marketings through the market. After the low point in prices, they rose for about 11 days to a new price peak. This peak came slightly later than 2 weeks after the heaviest Benton Harbor sales period. During the prewar years 1938-42, prices were higher towards the end than at the beginning of the season. The reverse was true for the 1943-47 average. Wide variations from these patterns occurred in individual years.

If we use $1.50 as the season average price for Elberta peaches on

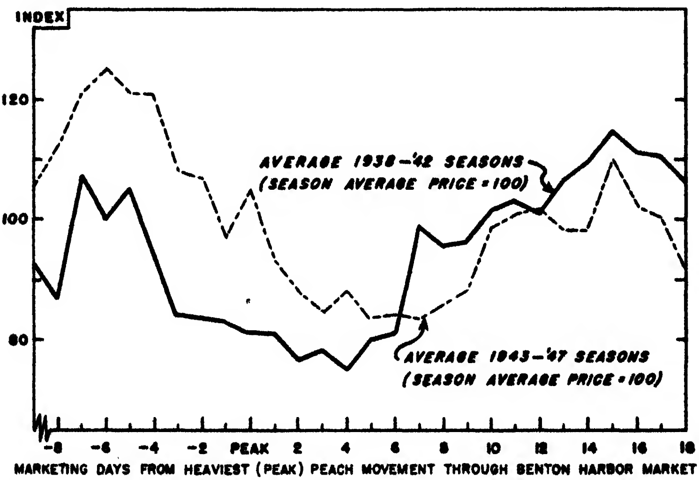

Fig. 3. Seasonal variation in the price of Elberta peaches over the Benton Harbor Market, 1938-42 and 1943-47 seasons.* The bulk of the Elberta peach movement through the Benton Harbor Market comes during the 2-week period from 6 days before to 8 days after the peak peach movement (the middle day during the heaviest week's sales). During the latest 5-year period the price rise from the seasonal low point until near the end of the season was less than in 1938-42.

*Data from annual summaries of Benton Harbor Market News Report—U.S.D.A., Production and Marketing Administration, and Michigan Department of Agriculture. Unweighted average of daily prices for season = 100.

[1]Since the peach marketing periods came at widely different calendar dates in different years, the five season averages were obtained by using the day with the heaviest peach sale through the Benton Harbor Market as the base date each year to "center" the season and tabulating prices for each marketing day before and after these bases. A simple average of relatives was used to combine the 5 years.

the Benton Harbor Market, (average 1938-42 = $1.57), peach prices reached a peak of about $1.65 a bushel early in the season, fell in 7 to 10 marketing days to about $1.20 per bushel, then rose in 11 marketing days to about $1.79 late in the season.

In 1946 approximately three-fourths of the Elberta peaches sold through the Benton Harbor Market moved during the declining price period. Most of the other one-fourth moved during the period of rising prices later in the season. In other words, during the rush of the bulk of the peaches to market the price was declining at the rate of 4 to 5 cents per marketing day.[1] Under such conditions it is understandable why growers feel that they cannot afford to ripen peaches two or three extra days when their fruit has the necessary size and grade for selling. As long as dealers will pay premium prices for immature peaches, they will get them. For those growers whose peaches will not reach the necessary standard of maturity before the low point in prices, there seems to be a double advantage in marketing at somewhat more than average ripeness. They sell a larger volume on a rising market.

Attitude of the "Trade"

The fact that the practice of buying "green" peaches is almost universal suggests that there must be a reason for it. One good reason frequently heard is that "I've never lost any money on green peaches but I have on ripe ones." Not enough has been done to find out why wholesalers and retailers stock up on "green" peaches to the apparent displeasure of their customers and the detriment of later sales. A complete answer to why this is done would go a long way towards explaining why riper peaches are not marketed. It is possible that the various dealers do not realize the extent of the harm to retail sales this practice causes. The effect of these "green" peaches on consumer demand could and should be studied. There is every reason to believe that if evidence on sales and profits can be shown to favor the sale of riper peaches, dealers would attempt to sell them.

Length of Marketing Process

In a check of 17 shipments during the 1946 season it was found that the trip from the packing house to consumer took from 2 to 12 days and averaged about 4½ days. Consumers were still using the

[1]The rate of decline for the steepest 7-day period was about 4 percent (6 cents per bushel) per day in 1938-42, and for the steepest 9-day period in 1943-47 it was 4½ percent (7 cents per bushel) per day on the basis of $1.50 peaches.

fruit for 3½ days after purchase, on an average. This meant that peaches picked on the afternoon of September 20 and packed and shipped on September 21 would reach the consumer about September 25 or 26 and that the last peach would be used September 29. Dealers would undoubtedly like to shorten this period. Some chains and others in nearby markets have reduced the time from packing house to retail store to one day, but this is not possible for all dealers and areas. Peaches are mostly picked to stand up under the maximum average shipping time rather than on the basis of the length of marketing period expected for nearby consumers and distant consumers. An organization with a distribution system geared to handling peaches in 3 days from the packing shed is understandably reluctant to handle peaches that begin to deteriorate rapidly at 3 days. They need some margin of safety in case sales are slow. In this connection a great deal more technical information is needed on the rapidity of ripening and deterioration of green-ripe, firm-ripe, and tree-ripe peaches under normal and under refrigerated temperatures. With detailed and reliable information of this type, a distribution organization can begin to work out methods to market peaches of a more satisfactory degree of ripeness.

Control of Rots

Rots are a greater problem in tree-ripened peaches than in peaches shipped at the usual ripeness. The main reason for increased rots is the longer period during which the peach may become infected and rot. Until rots are controlled, both in the orchard and in the packing house, the shipment of tree-ripe peaches in years of bad rot infection is likely to be small even though all other problems are solved.

The fact that about 60 percent of the rots recorded in retail store tests were at the stem end indicates a possibility that the weakest link in rot control is during the period immediately after harvest when the infection apparently enters the peach through a picking injury. It is usually easier and safer to prevent an infection than to allow infection to develop and then attempt to stop its growth. This would mean more prompt treatment for rot control after picking. Because of the rapid rate of spread of these rots, this may mean treatment within an hour or two instead of after the common overnight wait.

The "stericooling" process described in the footnote on page 387 was tested for the first time in Michigan in 1947 and offers consider-

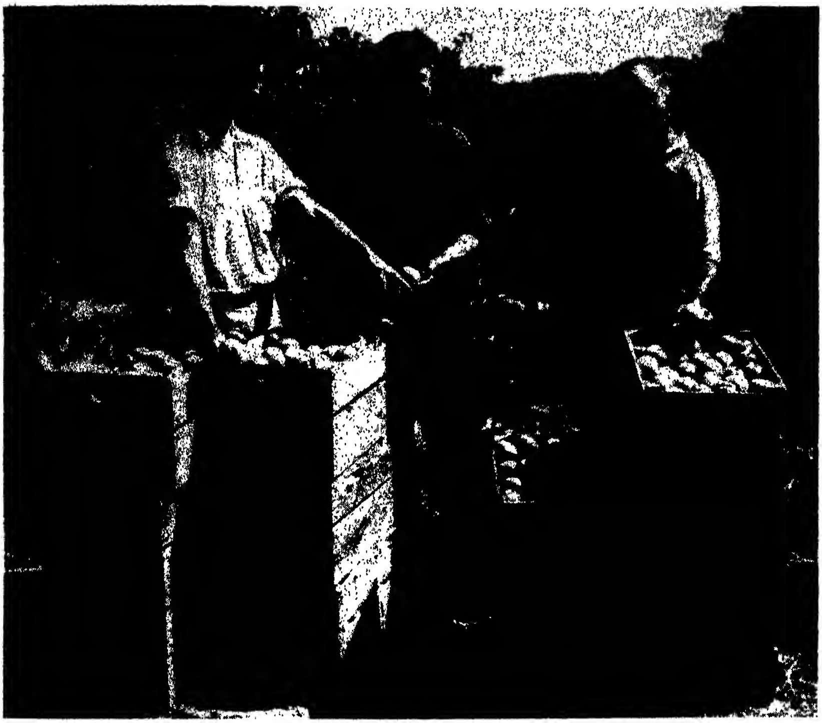

Fig. 4. Lawrence Boger pointing out to Bill Voight and Forrest Steimle the reduced yield obtained in the Steimle Brothers orchard when peaches were picked at the hard-ripe instead of tree-ripe stage.

able hope of more effective rot control in the critical period after harvest. Several experimental shipments of peaches treated with this process were made in 1947.[1] Of those shipments checked by post-card customers reported about 18 percent rot in the dust-treated peaches compared to about 2 percent for those in stericooled lots. The sulfur dust treatment in connection with the defuzzing operation is a standard treatment for rot control in Michigan.

Stericooling apparently arrests the ripening processes in the peach as well as helping prevent rots. This would permit the harvesting and marketing of riper peaches regardless of its effect on rot control.

Aside from the question of stericooling there are still differences of opinion among members of the trade on the effectiveness in rot

[1]H. A. Cardinell, Horticulture Department, Michigan State College, and C. G. Barr, of the John Bean Division of the Food Machinery Corporation, Lansing, conducted these tests.

control of such practices as precooling and refrigeration for short hauls. Many dealers believe that precooling increases rather than decreases rot breakdown on short hauls. The answers to some of these questions may be available in present experimental data. For those questions where this is not the case, further tests under ordinary trade conditions as well as under laboratory conditions are needed.

Ripeness at Harvest and Yield

There is some experimental evidence of remarkable increases in yield due to ripening of peaches beyond the usual picking date. In connection with the shipping tests two experiments were conducted to check yields under normal and tree-ripened harvest conditions.[1]

In one experiment 101 trees were picked at the usual stage of ripeness and 101 adjoining trees were picked at the tree-ripened stage (Table 9). It was found that harvesting at the usual ripeness yielded 230 bushels, while the tree-ripened trees yielded 272 bushels or about 18 percent more.

TABLE 9—*Yield tests—hard-ripe compared with tree-ripe peaches, Berrien County, Michigan, 1947 season*

Halehaven (Steimle Orchard—36 trees)			Halehaven (Randall Orchard—82 trees)			Elbertas (Steimle Orchard—84 trees)**		
Picking date	Hard-ripe	Tree-ripe	Picking date	Hard-ripe	Tree-ripe	Picking date	Hard-ripe	Tree-ripe
	(bushels)			(bushels)			(bushels)	
Sept. 5	19.5	......	Sept. 4	18.0	......	Sept. 17	4.0	......
Sept. 8	......	6.5	Sept. 8	59.0	46.5	Sept. 20	45.0	......
Sept. 11	12.0	14.0	Sept. 10	......	47.0	Sept. 22	......	30.0
Sept. 13	......	10.5	Sept. 12	36.0	44.0	Sept. 30	36.0	49.0
						Oct. 3	......	24.0
Total	31.5	31.0*	Total	113.0	137.5	Total	85.0	103.0
TOTALS							229.5	271.5

*Mr. Boger estimated that 10 percent of the peaches were not harvested because of brown rot infection. This was not as important in the hard-ripe harvested trees.

**About 10 peaches per tree fell from the tree-ripe and other trees in the eight days following the September 21 storm. From 4 to 15 peaches were left on the trees after the last picking. This seemed to be general through the orchard, as the foliage was very heavy and beginning to turn yellow by the end of the harvest

[1]By Lawrence Boger and Robert Kramer, graduate students, Economics Department, Michigan State College.

Forty-two of the trees were Elberta and 59 were Halehaven. Three pickings were made for each degree of ripeness except for one block of 18 trees picked only twice. It took an average of 5.8 minutes per bushel to harvest each of the 230 bushels of hard-ripe peaches and 5.7 minutes per bushel to harvest each of the 272 bushels of tree-ripe peaches.

The yield increases and harvest labor did not tell the whole story, however, for where about 7 percent of the peaches of usual ripeness were noticeably bruised by the time they reached the packing house, one-third of the tree-ripened peaches were so bruised. About a fourth of the tree-ripened peaches that were sound when they arrived at the packing houses were bruised by the present grading machinery where a much smaller percentage was noticeably bruised in peaches of usual ripeness. Once through these harvesting and grading hazards, several shipments were successfully marketed in special cell-box cartons and in wooden bushel "spruce" boxes.

With the present handling and marketing methods only a limited volume of peaches can be marketed successfully at the tree-ripened stage. In the future with more efficient and immediate processing use of peaches too ripe or too bruised to pack well, it may be possible to pick and market a large proportion of the crop at a riper stage. Sales tests have indicated that the principal bottleneck is not the lack of consumer demand for riper peaches, but rather the lack of technical "know how" to produce and handle them. With the harvest of a riper peach there will be a need for utilization of a larger volume of peaches that will become too ripe to pack. Some shippers are making use of these for freezing or canning. Possibilities of increasing such uses should be explored.

In the latter part of this experiment, 42 Elberta trees were picked at the usual ripeness and 42 trees at tree-ripe stage. By the time of the storm on September 21 about 57 percent of the peaches were picked from the trees where normal methods (ripeness) were used and less than 2 percent from the tree-ripened trees. The drop loss caused by the storm was accurately checked for the trees being picked at the tree-ripe and the hard-ripe stages. This showed that the "tree-ripe" trees lost about 4 percent, while the hard-ripe ones lost about 3 percent of their total yield.[1] In other orchards where the storm was more severe, the drop losses were much heavier.

[1]Based only on the peaches left on the trees (43 percent left on hard-ripe and 98 percent left on tree-ripe trees), the tree-ripe ones lost about 4 percent and the hard-ripe lost about 7 percent.

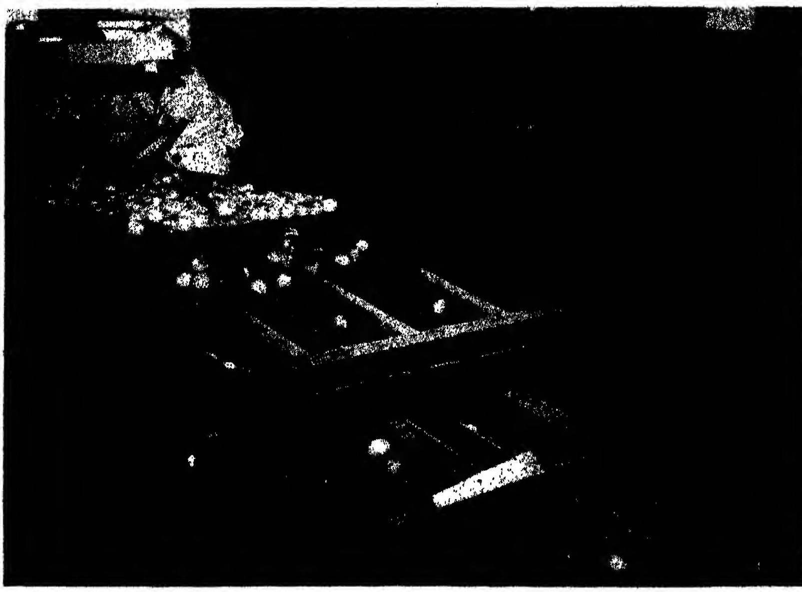

Fig. 5. The end of the grading table and the peach sizer. It is at this stage in the commercial packing operation that much of the bruising of soft peaches occurs.

In another phase of this experiment the size and degree of ripeness of 12 Elberta peaches on four different trees were measured for 14 days from the time they were considered mature until tree-ripe. These peaches were tagged and daily measurements of circumference were made with a flexible steel tape. These peaches grew about 20 percent in size (volume) during the period from hard-ripe to tree-ripe peaches. This should be compared with the 20 to 30 percent price decline that normally occurred between the beginning of the volume movement and 3 to 4 days past the peak in volume harvested. About half this swelling occurred during the first 3 days, with the remainder during the next 9 days. The storm on the afternoon of September 21 (on the third day of these measurements), with the cool weather following it, may have slowed peach growth considerably.

A comparison of the growth of these peaches between degrees of ripeness, as indicated by appearance, showed that about half of the increase in size occurred between the time they were adjudged hard-ripe and the start of the firm-ripe stage. The remaining swelling oc-

curred between the beginning of the firm-ripe and the beginning of the tree-ripe stages. Thus, about 50 percent of the swelling over that occurring by the normal picking stage had taken place by the time the peaches were firm-ripe. At Illinois, Dorsey and McMunn showed slightly greater volume increases than those reported here. They concluded that growers could take advantage of most of this increase in size by picking at a firm-ripe stage or later.[1]

A Reliable Test for Ripeness

During the yield tests the plots were visited daily in order to determine ripeness and/or to record the data on peach growth. In spite of this close attention, a large part of the tree-ripe pickings were too ripe to handle successfully. Some of the supposedly "normally" ripe Halehaven peaches were more nearly firm-ripe than hard-ripe. This illustrates a major problem. Until and unless a reliable measure of ripeness suitable for use by pickers is developed, the picking of a peach of a given degree of ripeness will be a hit-or-miss proposition. There is no satisfactory standard test for ripeness in general use even in laboratory work. Even if such an indication of ripeness cannot be developed at once, there is much to learn through studies of the methods of growers who are successful in producing and picking peaches of a uniformly satisfactory ripeness.

Conclusions

There is room for a great deal of laboratory experimentation before or in connection with further experimental marketing of tree-ripened peaches. With adequate answers to the physiological reactions of peaches under varying conditions, dealers would be able to handle and growers would be able to market riper fruit. There is still considerable progress to be achieved, so far as ripeness is concerned, in marketing a true firm-ripe peach, let alone a tree-ripe one. An immediate aim of marketing more firm-ripe peaches would be more feasible from the producers' and dealers' standpoint and might better satisfy the consumer than the so-called "tree-ripened" product.

In the immediate future there are at least eight types of information that need to be obtained if marketing agencies and growers are to deliver appreciable quantities of riper peaches to consumers.

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[1]M. J. Dorsey and R. L. McMunn, Bulletin 507, "Tree Conditioning the Peach Crop," University of Illinois Agricultural Experiment Station, Urbana, Ill.

1. How ripe does a peach need to be when picked if the highest quality is to be preserved to consumers in 2 to 8 days or highest "market" quality? Is it possible through temperature control to pick peaches before the tree-ripe stage and have tree-ripe quality in 4 to 6 days? What proportion of the final swelling comes before the peak in market quality?

2. Does the practice of dealers in stocking up on "green" peaches slow sales as much as is commonly believed? If this practice decreases sales, why do dealers persist in the practice? In what ways can they be encouraged to handle fewer "green" peaches?

3. To what extent can the marketing period be shortened? To what extent can individual dealers benefit by gearing the ripeness of the peaches they purchase to the expected length of the marketing period?

4. How can rots in peaches be prevented or be controlled?

5. What are the best uses for peaches too ripe to ship? With riper harvesting of peaches there will be greater need for uses for those too soft for packing.

6. In what ways can the added risks of price declines, over-ripeness and drops be insured against or predicted so that the individual grower can better judge whether to pick peaches at a riper stage?

7. Develop a reliable "field" test for ripeness. Also develop a reliable and usable packing house test for ripeness to sort peaches on the basis of ripeness before packing.

8. Continue to develop and test packages with the aim of reducing package costs and increasing peach protection and consumer acceptance. Develop packing machinery to handle riper peaches.

NEW FUNGICIDES FOR TOMATOES

By M. C. STRONG
SECTION OF BOTANY AND PLANT PATHOLOGY

THE YIELD of marketable tomatoes produced in Michigan is reduced nearly every year by attacks of three leaf diseases commonly called "blights". These diseases are early blight caused by *Alternaria solani*, Septoria blight caused by *Septoria lycopersici*, and late blight caused by *Phytophthora infestans*.

Of these three diseases, the last named is by far the most devastating because it spreads rapidly and kills entire plants under favorable weather conditions such as prevailed in the eastern and central states in 1946 when heavy losses were sustained. The other two blights usually progress more slowly and result in a gradual defoliation (Fig. 1) which reduces the fruit-producing capacity of the plant and subjects the fruits that are produced to sunscald and other injuries. Fruits thus exposed to direct sunlight usually fail to produce a good red

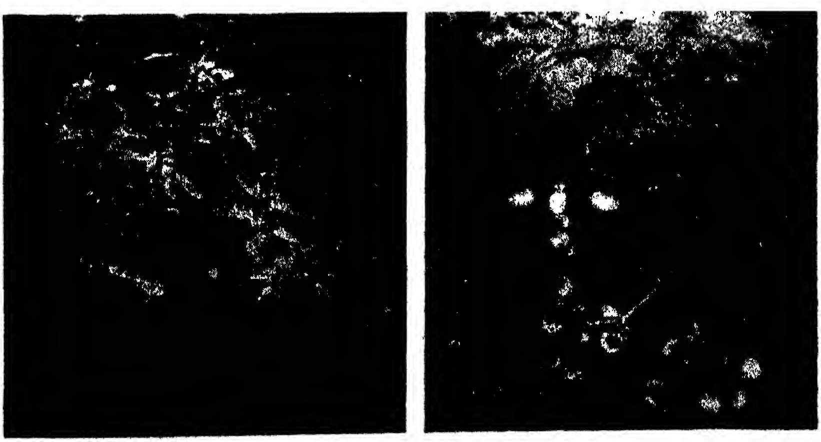

Fig. 1. Showing defoliation of tomato plant (B) caused by blight, in comparison with healthy plant (A) protected from infection by applications of a fungicidal spray. Note exposed fruit (B) which are affected with sun scald and rot.

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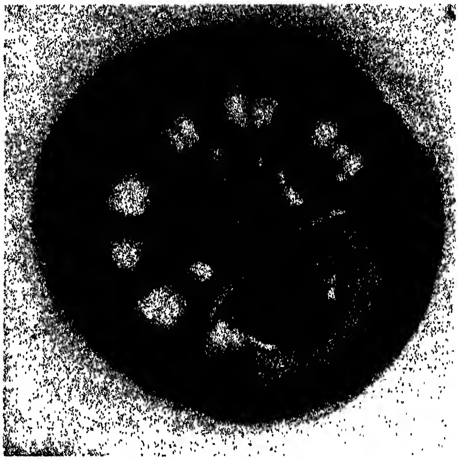

Fig. 2. Showing tomato fruit affected with Alternaria rot, a common result of early blight infection.

color, the lack of which reduces their grade. Early and late blight fungi also produce characteristic fruit rots (Fig. 2) which increase the percentage of culls.

Another disease which enters into this production picture is anthracnose, a ripe fruit spot (Fig. 3) caused by *Colletotrichum*

Fig. 3. Tomato fruit infected with anthracnose, a ripe fruit spot caused by Colletotrichum phomoides.

phomoides. This trouble also reduces the grade of fruit, and is often prevalent on late canning varieties that are left to ripen on the vine.

In the past, the standard treatment for these troubles has been timely applications of a copper spray or dust. However, in the last 5 years many new fungicides have been developed. Several of these new materials have been tested on tomatoes and compared with various copper fungicides. The results of these trials are here reported. The materials tested, their manufacturers, and rates of application are listed in Table 1.

TABLE 1—*Spray materials tested*

Trade name	Fungicidal chemical	Manufacturer	Rate of application
Bioquin 1	copper-8-quinolinolate	Monsanto Chem. Co.	1 lb.—100 gal.
Bordeaux mixture	copper sulfate	homemade	8 lb.—100 gal. plus 8 lb. lime
Copper zinc chromate	copper zinc chromate	Carbide and Carbon Chem. Corp.	4 lb.—100 gal.
Cuprocide	copper oxide	Rohm and Haas Co.	2.4 lb.—100 gal.
Dithane 14	disodium ethylene bis dithio carbamate	Rohm and Haas Co.	2 qt.—100 gal. plus 1 lb. zinc sulfate and ½ lb. lime
Dithane Z78	zinc ethylene bis dithio carbamate	Rohm and Haas Co.	2 lb.—100 gal.
Fermate	ferric dimethyl dithio carbamate	E. I. duPont Co.	2 lb.—100 gal.
No. 341	2 heptadecyl glyoxalidine	Carbide and Carbon Chem. Corp.	1 gal. —100 gal.
Omilite	polyethylene polysulfide	Goodrich Rubber Co.	2 qt.—100 gal.
Parzate	zinc ethylene bis dithio carbamate	E. I. duPont Co.	2 lb.—100 gal.
Phygon (wettable)	2, 3 dichloro napthoquinone	U. S. Rubber Co.	2 lb.—100 gal.
Puratized	phenyl mercuric triethanole ammonium lactate	Gallowhur & Co.	1 pt.—100 gal.
Tss wax emulsion	none	experimental	

METHODS

Southern-grown tomato plants were used in these tests because it is the common practice of many processing companies to furnish such plants to their growers. In 1945 the variety planted was Early Baltimore; in 1946, Rutgers; and in 1947, Wisconsin 55. Randomized plots were laid out in a field where tomatoes had been grown the year before and leaf diseases had been present. In addition, the soil was infested with the causal fungus of anthracnose by raking in cooked grain on which this organism was growing.

In 1945 and 1946 there were 26 plants per plot and in 1947, 24 plants. Plots were always replicated four times. Plants were set 3 feet apart in the row, and rows were alternately 3 and 6 feet apart, leaving ample space for the passing of spray equipment.

The first spray was applied when the first cluster of fruit was well developed or about the middle of July. Five applications were made at 2-week intervals which carried the spray program into September. Sprays were applied with a power sprayer of wheelbarrow type at 200 pounds pressure.

In 1945, Alternaria and Septoria blights were present, while in the last two seasons only Alternaria blight appeared. No late blight was observed. There was a slight amount of anthracnose infection in 1945.

In 1946, additional tests were conducted on the Elwyn Isley* farm in Lenawee Co. The variety planted was Pritchard, and the plots were approximately three-fourths acre in size. Sprays were applied with power equipment mounted on a truck. Five applications were made at 10-day intervals, beginning at the time of setting of the third cluster of fruit. The prevalent disease in these plots was Septoria blight. Some anthracnose appeared late in the season. Defoliation and anthracnose counts were made but yield data were not obtained.

RESULTS

At East Lansing ripe fruit were picked at weekly intervals, graded and weighed. Yield data were based on weight of marketable fruit. Data on anthracnose control were based on percentage of culls due to this disease. Blight control estimates were based on defoliation counts made in September.

Because the 1947 season was very short, the yield was only one-third to one-half as large as normal. This makes it very difficult to compare 1947 yields with those of the other two seasons. Consequently, instead of enumerating the yield data secured, the spray materials tested have been rated from best to poorest on the basis of yield and also blight and anthracnose control for the three seasons. This rating is shown in Table 2.

*The author wishes to express appreciation to Mr. Isley for his cooperation in these tests.

TABLE 2—*Rating of spray materials tested, from best to poorest on the basis of yield, blight and anthracnose control*

Year and location of test	Yield	Blight control (Alternaria, Septoria)	Anthracnose control
1945 East Lansing	1 Cuprocide 2 Fermate 3 Bordeaux 4 Untreated 5 Wax emulsion	1 Bordeaux 2 Cuprocide 3 Fermate 4 Untreated 5 Wax emulsion	1 Fermate 2 Cuprocide 3 Bordeaux 4 Untreated 5 Wax emulsion
1946 East Lansing	1 Tribasic copper 2 Zerlate alternating with tribasic copper 3 Zerlate 4 {Phygon* / No. 341 5 Fermate alternating with tribasic copper 6 Dithane 14 7 Fermate 8 Untreated 9 Bordeaux 10 Omilite 11 Puratized	1 Bordeaux 2 Tribasic copper 3 Dithane 14 4 Phygon 5 Zerlate alternating with tribasic copper 6 Zerlate 7 No. 341 8 Fermate alternating with tribasic copper 9 Puratized 10 Fermate 11 Untreated 12 Omilite	
1946 Lenawee Co.		1 Bordeaux 2 Bordeaux alternating with Fermate 3 Tribasic copper alternating with Fermate 4 Zerlate 5 Fermate 6 Untreated	1 Zerlate 2 Fermate 3 Tribasic Copper alternating with Fermate 4 Bordeaux alternating with Fermate 5 Bordeaux 6 Untreated
1947 East Lansing	1 Phygon 2 Copper zinc chromate 3 Parzate 4 Untreated 5 Dithane Z78 6 Tribasic copper 7 Cuprocide 8 Bordeaux 9 Zerlate alternating with tribasic copper 10 Bioquin 1 11 Zerlate	1 Bordeaux 2 Cuprocide 3 Tribasic copper 4 Phygon 5 Copper zinc chromate 6 {Zerlate* / Parzate / Dithane Z78 7 Bioquin 8 Zerlate alternating with tribasic copper 9 Untreated	

*tie

DISCUSSION

As has been frequently observed, there was no relationship between yield and disease control. Sometimes the best fungicides have a deleterious effect on yield that are only overcome in seasons when diseases are very prevalent and severe. Bordeaux mixture, Cuprocide, and Tribasic copper sulfate seem to hold the lead on the basis of blight control with copper zinc chromate, Dithane 14, and Phygon following closely.

Omilite appears to have no fungicidal value in controlling these tomato diseases, and failed to enhance the effectiveness of tribasic

copper when used with it as a sticker. Puratized was not satisfactory. The wax emulsion was not expected to have any value as a fungicide but was tried in the belief that it might reduce the percentage of culls due to blossom end rot which it did; however, any value it had in this respect was more than offset by its depressing effect on yield.

Zerlate and Fermate control anthracnose, the former being superior in that it will also afford some protection against Alternaria blight. However, neither will control late blight. The alternating schedule with Zerlate and a copper is superior to Zerlate alone against blight.

Dithane 14, a liquid that is mixed with zinc sulfate and lime to make the spray, was a somewhat more effective fungicide than Dithane Z78 or Parzate which are essentially the same chemical in a dry, powdered form. The two last named have the advantage that they may be mixed with diluents and applied as dust treatments.

No. 341 showed some promise in 1946 but was withdrawn by the manufacturer owing to production problems. Bioquin 1 was disappointing in these tests but has been reported elsewhere to be effective against anthracnose.

CONCLUSIONS

It is seldom advisable to make recommendations about a fungicide on the basis of a single season test. However similar tests have also been conducted in other states where a variety of weather and disease conditions prevailed. On the basis of these cooperative tests, some conclusions may be drawn.

Phygon, the Dithanes and Parzate offer dependable control of the blight diseases but are somewhat more expensive than the insoluble coppers or bordeaux mixture. Phygon has been reported to be slightly toxic to foliage and to cause a spotting of tomato fruit. These effects were not observed in Michigan tests.

Fermate, Zerlate and Bioquin 1 will control tomato anthracnose effectively. Fermate has little value in controlling the blight diseases, while Zerlate is partially effective against early blight but not against late blight. Bioquin 1 seems to offer control of anthracnose and blight as well. However, it is not so effective in the latter capacity as the insoluble coppers or bordeaux, and is considerably more expensive.

USE OF THE AMMONIUM SALT OF TRICHLOROACETATE, THE SODIUM SALT OF TRICHLOROACETATE, AMMONIUM THIOCYANATE, AND HERBICIDE "PB", IN THE ERADICATION OF GRASSES, AND THE EFFECT OF THESE CHEMICALS ON STRAWBERRY AND RASPBERRY PLANTS[1]

By R. F. CARLSON and J. E. MOULTON[2]
SECTION OF HORTICULTURE

GRASSES, especially quack grass (*Agropyron repens* L.), often are a serious problem in cultivated crops. It has been reported (2, 7) that IPC (isopropylphenylcarbamate) is effective in controlling quack grass when applied to the rhizomes. Since this compound is comparatively insoluble and has no appreciable effect when applied to the top of grasses, several water-soluble compounds were tested in the greenhouse in an attempt to find a herbicide effective when applied to the foliage.

MATERIALS AND METHODS

The compounds tested were the ammonium salt of trichloroacetate, the sodium salt of trichloroacetate, ammonium thiocyanate, and herbicide "PB". The grasses used in these tests were quack grass (*Agropyron repens* L.) and Kentucky bluegrass (*Poa pratensis* L.) which often become troublesome weeds in small fruit plantations. The grasses were started in flats (19 x 14 x 3½ inches) in the greenhouse by transferring rhizomes of quack grass and clusters of bluegrass sod from the field. Applications of the chemicals were made with a knapsack sprayer delivering a cone-type spray or with a sprinkler with small holes in the rose. Applications were made at various stages of growth of the grass from planting time to one foot tall.

[1]This work was made possible through a grant from The Pittsburgh Plate Glass Company, Pittsburgh, Pennsylvania.

[2]The authors wish to acknowledge the aid of E. I. du Pont de Nemours & Company, Inc., Wilmington 98, Delaware, in supplying the ammonium salt of trichloroacetate; the B. F. Goodrich Chemical Company, Cleveland 15, Ohio, for supplying the herbicide "PB"; and The Dow Chemical Company, Midland, Michigan, for furnishing the sodium salt of trichloroacetate.

ARTICLE 30-53

RESULTS

The Ammonium Salt of Trichloroacetate

Preliminary tests with the ammonium salt of trichloroacetate (hereafter in this paper trichloroacetate will be referred to as TCA) as a herbicide were made by E. I. du Pont de Nemours & Company, Inc., in 1947 (1). These tests suggested further investigations. Later reports at the annual meeting of the North Central Weed Control Conference indicated that the ammonium salt of TCA is effective in the control of Johnson, Bermuda, and quack grass (3, 5, 6, and 8).

The equivalent of one gram of the actual acetate was prepared from a 20-percent stock solution and applied to each flat with a sprinkling can at each of the following stages of growth: a) At the time of planting, b) just as the shoots were emerging, and c) when the plants were 5 and 12 inches tall. Five hundred ml. of the solution were applied to each flat. This actually amounted to a soil application in the first two flats and a combination soil and foliage application in the other two flats. A fifth flat was left untreated as a check.

After 10 days there were no new shoots from the rhizomes in the flat treated immediately following planting. The grass treated when emerging was stunted and turned a dark green color. After 10 days the leaves turned brown and died. The two flats treated when the plants were 5 and 12 inches tall showed similar stunting and dark green color and only a few new shoots appeared, but the stunted plants finally withered and died (Table 1 and Fig. 1). That the re-

TABLE 1—*The response of quack grass to the ammonium salt of TCA. One gram of the salt in 500 ml. of water was applied to each flat at different stages of plant growth*

Stage of growth when treated	Date treated	Number of green grass shoots at dates indicated					Remarks
		Dec. 6	Dec. 20	Jan. 4	Jan. 18	Feb. 2	Mar. 2
At planting....	Nov. 18....	0	0	0	0	0	No growth
Emerging......	Nov. 24....	7	4	0	0	0	No regrowth
5 inches.......	Nov. 30....	97	89	64	52	43	Dwarf—Dark green
12 inches......	Dec. 6....	89	87	57	52	52	Dwarf—Dark green
Control.......	....	92	103	123	137	178	Lush growth

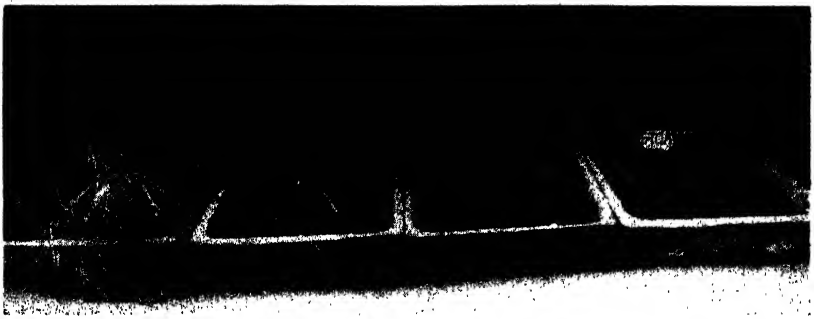

Fig. 1. Quack grass, untreated flat at left. The other three flats, left to right, each were treated with one gram of the sodium salt of TCA in 500 ml. of water at each of the following stages of growth: when 12 inches tall, when 5 inches tall, and when emerging.

sponse is systemic was indicated by the slow death of the plants and the absence of burning on the leaves. The younger the grass, the greater was the response to the treatment.

The Sodium Salt of TCA

The sodium salt of TCA, a water-soluble powder, was applied to other flats containing quack grass in a similar manner, at the same time and at the same rate (1 gram per flat) as the ammonium salt of TCA treatments described above. This was done to compare the relative effectiveness of the two formulations. There was no noticeable difference in their effect on quack grass, both being equally effective in slowly retarding the growth. That is, the grass after 6 to 8 days turned dark green, became stunted, then chlorotic, and only a small percentage recovered.

Kentucky bluegrass responded in a similar way to these chemicals.

Use of a Wetting Agent with the Ammonium Salt of TCA and the Sodium Salt of TCA

Since grasses do not adsorb aqueous solutions readily, Dreft was used at the rate of 0.5 gram per 500 ml. of solution to get better wetting of the foliage. The materials, the ammonium salt of TCA and the sodium salt of TCA, were each used at the rate of 3, 4, and 5 grams per flat, or 120, 160, and 200 pounds per acre respectively, in order to compare their effectiveness and the approximate rates

per acre required to kill the grass. The quack grass at the time of application was from 12 to 15 inches tall and well established in the flats. Each flat averaged 150 "crowns" per flat, a "crown" being considered a focus at the surface level of the ground where one to several "grass-shoots" originated. A knapsack sprayer was used to apply 500 ml. of the solution per flat. This volume was enough to wet thoroughly the foliage of the grass in the individual flats, but not sufficient to moisten the soil.

The results are shown in Table 2. As was the case in previous tests, the effect of these materials was gradual and it is doubtful that the wetting agent increased the effectiveness of the compounds. Again, the two formulations of TCA were equally effective as herbicides for quack grass.

Examinations of the rhizomes and roots three months after treatment showed that the underground parts of quack grass had been injured severely by the various chemicals (Fig. 2). As indicated in Table 2, the different concentrations of the materials produced vary-

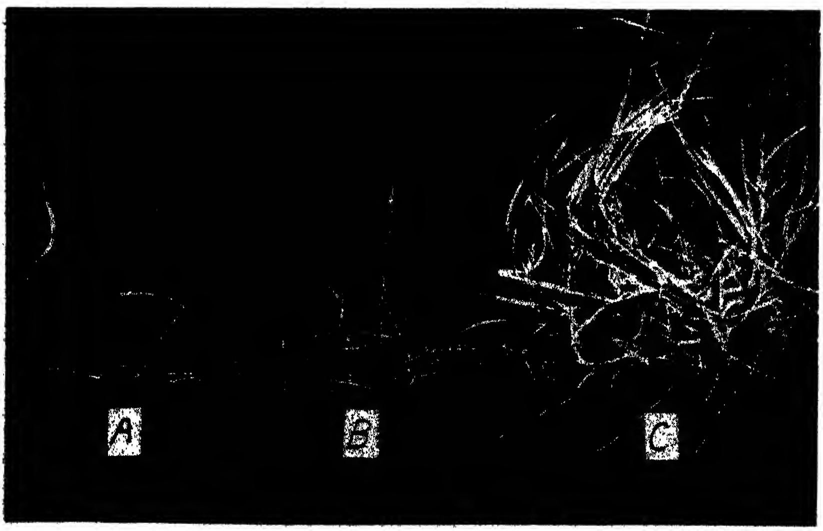

Fig. 2. Response of quack grass to foliage applications with the sodium salt of TCA. A. At the rate of 5 grams per flat. B. At the rate of 3 grams per flat. C. Control. The foliage, rhizomes and roots at the higher concentrations (A) are dead, while some "dwarf" growth appeared at the lower concentration (B). Note new growth of rhizomes in control (C).

TABLE 2—*Number of quack grass crowns alive per flat at 15-day intervals following individual foliage applications of the ammonium salt of TCA, the sodium salt of TCA, and ammonium thiocyanate at three concentrations. Dreft was used as a wetting agent at the rate of 0.5 gram per 500 ml. of the solution per flat*

Grams per flat	Approximate pounds per acre	Number of crowns alive at indicated days following treatment				Condition of rhizomes 2 months after treatment
		15	30	45	60	
			Ammonium salt of TCA			
3	120	144	67	60	60	20% alive. Some new rhizomes
4	160	139	53	46	15	4% alive. No new rhizomes
5	200	153	23	15	0	Dead
Control	0	142	147	152	155	Normal
			Sodium salt of TCA			
3	120	150	75	43	10	Few old rhizomes alive. No new rhizomes
4	160	157	60	38	5	2% alive. No new rhizomes
5	200	143	43	15	2	Dead
Control	0	147	153	156	156	Normal
			Ammonium thiocyanate			
3	120	151	113	114	112	80% alive. Many new rhizomes
4	160	143	102	108	108	30% alive. Few new rhizomes
5	200	128	53	32	12	3% alive. Some new rhizomes
Control	0	148	151	156	157	Normal

ing results. At the higher concentration there was little development of new buds and shoots, while at the lower concentration there was some weak growth.

Ammonium Thiocyanate[1]

It has been briefly reported (4) that ammonium thiocyanate (ATC) and 2,4-D mixed with the soil will control quack grass and Chrysanthemum weed (*Artemisia vulgaris* L.). In order to find out what effect ATC had on top growth of quack grass and to compare it with the ammonium salt of TCA and the sodium salt of TCA, several applications to flats of quack grass at various concentrations (3, 4, and 5 grams per flat) were made. The material was applied when the grass was 3 and 10 inches tall. The effect of this material was more pronounced when applied to the young plants than it was on the taller and better established quack grass. Table 2 shows that

[1]This material was supplied by Prof. A. M. S. Pridham of Cornell University who has also been testing this compound and suggested that it be included in these tests.

ammonium thiocyanate at the lower concentrations was not so effective as the ammonium salt of TCA and the sodium salt of TCA in reducing growth of the grasses.

Herbicide "PB"

Herbicide "PB" was suggested as a possible grass killer by the B. F. Goodrich Chemical Company. It was applied to flats of quack grass 10 inches tall in 10-, 20-, and 30-percent aqueous solutions. A number of broad-leaved weeds were growing in with the quack grass at the time of application. Four weeks after being sprayed the quack grass appeared normal, while all the broad-leaved weeds were dead. The herbicide "PB" is selective in its action, as these tests indicate, and may have value as a selective herbicide.

Response of Raspberry Plants to the Ammonium Salt of TCA

Five raspberry plants each of three varieties, Taylor, Latham, and Cuthbert, were sprayed with the ammonium salt of TCA when dormant and when in full foliage. The same number of plants of each variety were left untreated. The plants were transplanted in October from the field to the greenhouse and set in 8-inch pots and kept at 55° F. for 3 months, after which they were placed in a 75° F. room for forcing. The dormant applications were made November 28 in aqueous solution at the rate of 1,500 p.p.m. The foliage applications at the rate of 1,000 p.p.m. were made after the leaves had developed and new shoots had formed. In each case the plants were covered with solution, but not enough of the spray was applied to moisten the soil surface of the pot.

The first few leaves which appeared from lateral buds on the plants that received the dormant applications were dark green and some formative effects were observed. That is, the leaves did not grow to full size and appeared rugose. However, later leaves showed no such effects. Also, the new shoots arising from the roots were normal. This indicated a delaying action of the dormant application on the plants, but the effects were outgrown after 4 weeks and were not serious enough to retard the general growth of the plants.

The plants sprayed when in leaf showed symptoms similar to mineral deficiencies; that is, the margins of the leaves, and also areas between the veins were chlorotic 5 to 6 days following treatment. Four weeks later the margins of the leaves had turned brown while

the chlorotic regions between the veins remained unchanged or turned a darker green color. The effects produced by the ammonium salt of TCA at 1,000 p.p.m. sprayed on the foliage were not serious enough to appreciably check the growth of the plants. In both tests all varieties showed equal response to the treatments, while the check plants appeared normal.

Response of Strawberry Plants to the Ammonium Salt of TCA and the Sodium Salt of TCA

Strawberry plants of two varieties, Premier and Robinson, were grown in flats together with quack grass and Kentucky bluegrass. After the plants were well established and the grass was about 10 inches tall, applications of the ammonium salt of TCA and the sodium salt of TCA at concentrations of 500, 1,000, and 1,500 p.p.m. were made. Sufficient amount of the solution to wet the foliage was applied. This is approximately equivalent to 20, 40, and 60 pounds of the chemical per acre respectively. The strawberry plants were killed at all concentrations and the grasses were also severely injured, especially at the higher concentrations. The untreated flats of grasses and strawberry plants were normal.

Residual Effect in Soil Following Treatment with the Ammonium Salt of TCA

The residual effect of the ammonium salt of TCA was tested by saturating one flat of soil with one liter of a 1,000 p.p.m. solution and a second flat with one liter of a 2,000 p.p.m. solution. Red kidney beans were planted at weekly intervals in these flats. The soil was watered as needed. The beans from the first, second, and third plantings germinated and produced the first true leaves after which the plants gradually withered and died. The beans from the fourth and fifth plantings showed some injury along the margins of the first true leaves, but the plants recovered sufficiently to continue to grow. The beans from the sixth planting were apparently normal. This indicates that in moist soil the chemical will remain toxic to bean plants 40 to 50 days following soil applications at the above-mentioned rates.

SUMMARY AND CONCLUSIONS

1. The ammonium salt of TCA and the sodium salt of TCA were found equally effective in controlling quack grass and Kentucky bluegrass as tested under greenhouse conditions. Approximately 150 to

200 pounds per acre was required for a complete kill of the well established grass. The lower rates, 40 to 80 pounds per acre, controlled the young grass growth and retarded the taller and older grasses. The wetting agent, Dreft, did not materially increase the effectiveness of these compounds.

2. The herbicidal action of the ammonium salt of TCA and the sodium salt of TCA was slow on the grasses tested, suggesting that the materials were absorbed by the foliage and translocated to the underground parts (rhizomes and roots). The leaves gradually changed in color from a light to a dark green and after 4 weeks became chlorotic and withered.

3. Ammonium thiocyanate was not as effective as the ammonium salt of TCA and the sodium salt of TCA on grasses when used at equal concentrations.

4. Herbicide "PB" proved to be effective on broad-leaved weeds and did not injure the grasses.

5. Raspberry and strawberry plants were tested for resistance to the ammonium salt of TCA and the sodium salt of TCA. The strawberry plants were killed when herbicidal concentrations were used. Formative effects were produced on raspberry plants after dormant applications and deficiency symptoms after foliage sprays. Both effects were outgrown.

6. The ammonium salt of TCA in moist soil remained toxic to red kidney beans 40 to 50 days following soil applications.

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A COLORIMETRIC TEST FOR ESTIMATING THE PERCENTAGE MOISTURE OR THE STORAGE QUALITY OF FARM PRODUCTS OR OTHER DRY MATERIALS

By S. T. DEXTER
SECTION OF FARM CROPS

IN A PREVIOUS paper[1] a test was described in which the keeping quality of either hay or grain could be quickly estimated. This test was dependent upon the fact that certain chemicals become moist and and sticky when they are exposed for a brief time at a relative humidity above a critical figure.

To avoid molding of the ordinary farm crops under storage conditions in Michigan, the relative humidity of the air surrounding them in the bin or mow should not long remain higher than 80 to 85 percent. For storage in large quantities, or in a very tight storage, a lower initial figure would be necessary. In ordinary farm storage, there is some movement of air, with consequent lowered relative humidity and appreciable drying out in the course of the first few days, so that molding is avoided. To the contrary, in a tight storage with the air remaining at 80 to 85 percent relative humidity, molding of hay or grain will occur within a week or two at summer temperatures.

The test as described was designed to indicate whether grain or hay could safely be put in ordinary storage. This was done by simply shaking in a tight container a sample of grain with ammonium chloride, and observing whether the chemical became sticky or moist. While, with experience, it gives considerable indication of the degree of excess dampness, it gives little indication of extreme dryness. For those reasons, and for greater ease of reading over a much wider range, a further test has been developed, in which color changes indicate the degree of dampness of the product.

Two dry chemical mixtures have been devised, to be shaken up

[1]A Method of Estimating Whether Hay or Grain Will Keep in Storage. Mich. Exp. Sta. Quart. Bull. 30 (2) (Nov. 1948): 150-157.

ARTICLE 30-54

with the samples. With one chemical, a gradual color change from almost white to a deep red indicates a range of moisture content from 7 to 12 percent in oats or wheat. With the other mixture, a change from almost white to a deep blue indicates a moisture content range from 12 to 17 percent. (See color plate insert in center of this bulletin.) It should be recognized that these numerical values for percentage are not applicable to all materials. Thus, a pale blue color (meaning "suitable for ordinary storage") would be produced at entirely different moisture contents in sugar, starch, hay, flaxseed, etc.

OTHER USES

Since these tests cover a wide range, they have many other uses than for testing grain and hay. For example, small pieces of paper stored at various relative humidities will soon reach different equilibrium moisture contents. If any one of these pieces of paper is placed in a closed container and shaken up with a small amount of the indicator chemical, a color will be formed that is characteristic of the particular relative humidity in question. Or if a piece of wood is stored at any given relative humidity, it will reach a certain moisture content. If a few scraps of the wood are similarly shaken up with the chemical, a color will be formed that indicates the moisture content of the wood – or more important, the relative humidity at which it is in equilibrium. Such a test would, for example, reveal whether lumber was suitable for installing as flooring.

OTHER METHODS OF USE

In the case of ground mill feeds, flour, etc., the material being tested may readily contaminate the testing chemical unduly, or dilute the color. In such cases, it has been found both easy and rapid to place the chemical in a tissue-paper envelope, and to insert this in the container with the material to be tested. Within a very few minutes, the chemical reaches its characteristic color for a certain moisture content.

CALIBRATION OF THE TEST

Since the test can be used on such a variety of materials, it has seemed pointless – in fact, impossible – to calibrate it for all possible uses. If the "blue reagent" is used for testing filler tobacco, a certain shade of blue would indicate that the tobacco was at the proper mois-

ture content. If the "red reagent" is used on flooring, a light pink would indicate a suitable moisture content. When tested with the "blue reagent," wheat for storage in very large quantities should give a very light blue, but with the "red reagent" should give a dark red. For ordinary farm storage, a somewhat darker blue would be the proper condition. Hay suitable for baling or chopping into an unventilated mow should give a rather light blue; but for long hay, a darker blue would be permissible. In all these cases, as previously pointed out, the local conditions are of importance, and the chemical should be quickly calibrated on the job for the particular temperature and humidity condition in question. In general, testing of storage characteristics should be done at or near the temperature at which storage is to take place. In any case, the range of the test is so great that the moisture conditions of most "dry" materials will fall within it; if not, additional testing chemicals can be devised.

USE OF THE TEST

A small sample of the material to be tested is placed in a glass container. In general, filling about one-third full allows for convenient shaking. A small amount — the precise amount is of no consequence — of the testing chemical is added, and the mixture shaken thoroughly. Depending upon the readiness of evaporation from the surface of the sample, the approximate maximum color will be developed in from 50 to 200 shakes. With materials providing very free evaporation — such as tissue paper or sugar beet pulp—the color reaction may be even more rapid.

Many samples have been stored with the chemical over periods of several weeks, with no notable change in the color beyond that produced in the first minute or two.

In many cases, with experience, there is no object in shaking until the maximum color develops. For example, in testing oats or wheat, if after 10 shakes — 5 or 10 seconds — the color of the "blue reagent" is decidedly blue, the sample obviously is too wet to store.

PRINCIPLES OR THEORY OF THE TEST

Considerable adsorption of water takes place upon the crystal faces of a dry chemical before the water concentration becomes high enough to cause actual solution or observable wetting. This adsorption, or incipient solution, furnishes sufficient moisture, however, to initiate

various chemical (or physical) actions of other chemical systems, that, in this case, produce brilliant colors. The choice of chemicals that will indicate the moisture of the air is, of course, almost limitless. So also, there are a great number of color reactions that have been tried with more or less success. In the tests in question, it seemed desirable to use an indicator chemical that would give a somewhat sharp break in color at about 14-percent moisture in oats or wheat. This has been done. To the contrary, there would be no difficulty in providing a testing mixture that would show a strong break in color at, say, 12-percent moisture. Thus, as shown in the color plate, a chemical mixture has been prepared which changes from almost white to a deep blue in the range shown. In practice, it may be used to still higher percentages.

It seemed desirable to extend the range into drier materials, and in that range to provide a different color, to avoid any possible confusion. Another indicator chemical and a different color reaction was therefore used, as shown in the color plate.

CHEMICALS INVOLVED

In the mixture that gives a blue coloration, common table salt (Crystal Diamond Salt, not iodized) is used to adsorb the water. It does this very strongly, becoming wet and sticky, if the moisture content of the oats or wheat exceeds 15 percent. Even though it appears "dry" at 13 percent, a slight blue color develops. The chemicals that react to give the blue color are ferric ammonium sulfate (anhydrous) and potassium ferrocyanide. These chemicals are almost colorless, while the ferric ferrocyanide that is formed is an intense blue.

In the mixture that gives a red coloration, potassium thiocyanate is used to adsorb water. It does this much more readily than does common salt and becomes wet and sticky if the moisture content of the grain is above 11 percent. Even though it appears dry at 9-percent moisture, for example, there is nevertheless some moisture adsorbed, which leads to the reaction with ferric sulfate, giving the red color, ferric thiocyanate. This color is distributed over the surface of a filler (common salt), which has no part in the reaction.

It is evident that the chemicals going into the color reaction must not be as sensitive to moisture as the adsorbing chemical. Not so evident is the fact that none of the chemicals may interfere with the color reaction, nor may any of them chemically react with water, for

this would make necessary a sample of fixed size. Furthermore, no part of the chemical mixture may be porous or have great adsorbing capacity for water—as do wheat, oats, paper, etc., etc.—but rather, all must have solid crystal faces, which require only the most minute quantities of water for their saturation.

MANUFACTURE

Although it is theoretically possible for a private individual to manufacture these products at very slight expense, in actual practice it would be comparable to manufacturing one's own ink. When purchasing a bottle of ink, one is assured of a good standard product that "works". Consequently, patent applications assigned to Michigan State College have been made on this product, and it is anticipated that it will soon be on the market in a convenient and reliable form.

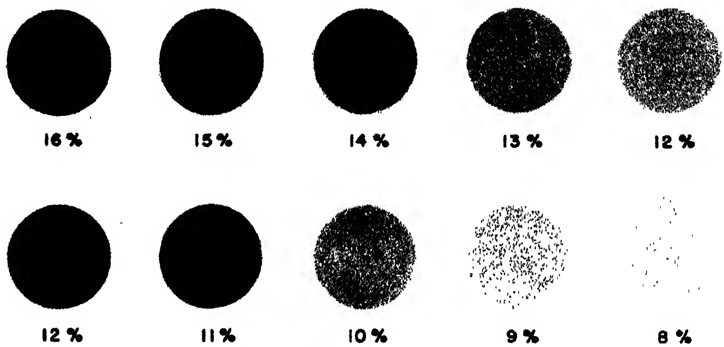

Plate 1. The colors are those resulting in the two testing mixtures when shaken up with wheat at the moisture percentages indicated.

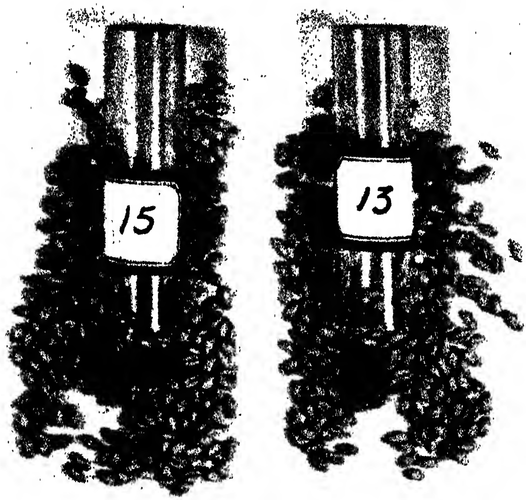

Plate 2. Wheat at 15 and 13 percent moisture content when shaken up with the blue testing mixture resulted in the colors shown.

THE CHEMICAL CONTROL OF CERTAIN FOREST SHRUBS: A PROGRESS REPORT

By MAURICE W. DAY
DUNBAR FOREST EXPERIMENT STATION

MANY THOUSANDS of acres of potentially productive forest land in the Lake States are covered with a stand of shrubs, making it difficult to establish stands of desirable tree species either by natural or by artificial methods. One of the major silvicultural problems of the region is the establishment of stands of timber upon these extensive brush areas and the securing of natural reproduction in understocked stands having a shrub under-story. More knowledge is needed regarding these shrub species and of the limitations and possibilities of the various methods of controlling them.

The problem of controlling woody plants is not confined however to the field of silviculture. Large sums are spent yearly in attempting to eradicate woody plants on right-of-ways along highways, railroads, drainage ditches and power lines. Farmers and ranchers are also often concerned with the eradication of woody plants from permanent pastures where their presence reduces the available forage.

The object of the work being described was primarily that of testing some new substances and methods that might prove of value in shrub control. While shrub control methods fall into three classes, namely chemical, mechanical and silvicultural, only the work dealing with chemical control will be considered here.

Ammonium sulphamate was the first substance tested on some of the shrubs. Several preparations of 2,4-D (2,4-Dichlorophenoxyacetic acid) were used. Two preparations containing DNOSBP (dinitro ortho secondary butyl phenol) were tested also. These preparations can be briefly described as follows:

1. Weedone, a product of the American Chemical Paint Co. containing the ethyl ester of 2,4-D. It was used in a water solution of 1,250 p.p.m.

ARTICLE 30-55

2. Dow A510 (2,4-Dow powder), a product of the Dow Chemical Co. containing the sodium salt of 2,4-D, and used in water solution of 1,000 p.p.m.

3. Dow G414, an experimental product of the Dow Chemical Co. containing 14-percent dinitro ortho secondary butyl phenol (designated DNOSBP for convenience). Used as an oil solution containing .05 pound of the toxicant per gallon.

4. Dow G512, containing 2,4-D in the form of the methyl ester plus one-half the concentration of DNOSBP found in G414. This was used in an oil solution containing .025 pound of toxicant per gallon and 1,665 p.p.m. of 2,4-D.

5. Dow G536, containing the methyl ester of 2,4-D. This was used in an oil solution at 1,000 p.p.m. and 1,665 p.p.m.

6. Dow G652, containing the methyl ester of 2,4-D in more concentrated form. Used in both water and kerosene solution at from 1,000 to 3,000 p.p.m.

7. Esteron 44, a Dow Chemical Co. product containing the isopropyl ester of 2,4-D. It was used in several different formulations.

The materials listed above were applied in several different manners. The foliage sprays were applied to the leaf surface of the shrubs with a knapsack garden sprayer. When used as a stem spray, the spray was applied from the ground line to a height of about 4 feet on all sides of the stem. The cut stump spray was applied in the same manner to freshly cut stumps up to 5 inches in diameter. Those materials listed as being placed in holes in the stem were poured into holes about ½ inch in diameter and extending about 1 inch into the stem. These holes were made with a special axe devised for use with sodium arsenite. One other method of application was used with the dry powder of A510, which was placed in slits in the bark cut so as to expose the cambium.

RESULTS

The results of the trials of the various herbicides have been summarized in Table 1. It is apparent that many inconsistent results have been obtained which indicate inadequate and incomplete experimentation; however, it is hoped that the results will provide some guides for further work along these lines.

TABLE 1—*Summary of results of chemical treatments*

Species	Formulation	Treatment	Reaction
Alder (*Alnus incana*)	methyl ester 1000 ppm	foliage spray	I
	methyl ester 1500 ppm	foliage spray	I–II
	ethyl ester 1250 ppm	foliage spray	I–II
	sodium salt 1000 ppm	foliage spray	I–IV
	methyl ester 1665 ppm. in kerosene	foliage spray	I
	DNOSBP .05 lb. per gal. in kerosene	foliage and stem spray	II–III
	methyl ester 1665 ppm. plus DNOSBP .025 lb. per gal. in kerosene.	foliage and stem spray	II
	sodium salt 1000 ppm. plus $NaClO_3$	foliage spray	I
	ammonium sulphamate	foliage spray	II
	methyl ester 3000 ppm. in kerosene	cut stump spray	I
	methyl ester 1665 ppm. in kerosene	cut stump spray	II
	methyl ester 1665 ppm. plus DNOSBP .025 lb. per gal. in kerosene.	cut stump spray	II
	DNOSBP .05 lb. per gal. in kerosene	cut stump spray	IV
	sodium salt 70% 2,4-D	powder placed under bark	I
Aspen (*Populus tremuloides*)	ethyl ester 1250 ppm	foliage spray	III–IV
	sodium salt 1000 ppm. plus $NaClO_3$	foliage spray	II–IV
	sodium salt 1000 ppm	foliage spray	III–IV
	methyl ester 1665 ppm. in kerosene	foliage spray	II
	ammonium sulphamate	foliage spray	II
	DNOSBP .05 lb. per gal. in kerosene	stem spray	I–II
	methyl ester 1665 ppm. in kerosene plus DNOSBP .05 lb. per gal.	stem spray	II
	methyl ester 1665 ppm. in kerosene plus DNOSBP .05 lb. per gal.	in holes in stem	III–IV
	methyl ester 1665 ppm. in kerosene	in holes in stem	II–III
	sodium salt 70% 2,4-D	placed in slits under bark	II
	ammonium sulphamate	in holes in stem	II
	methyl ester 3000 ppm. in kerosene	in holes in stem	III–IV
Aspen, big tooth (*Populus grandidentata*)	ethyl ester 1250 ppm	foliage spray	II
	ammonium sulphamate	foliage spray	II
	DNOSBP .05 lb. per gal. in kerosene	stem spray	I
Balsam poplar (*Populus Tacamahaca*)	methyl ester 1000 ppm	foliage spray	II
	ethyl ester 1250 ppm	foliage spray	I

All treatments made during the mid-season period July 1 to August 15. (1945-47).
Reaction types I, hypersensitive—II, sensitive—III, semi-tolerant—IV, tolerant.
All formulations are in water unless otherwise noted.
All formulations are of 2, 4-D unless otherwise noted.
The symbol DNOSBP refers to the toxicant dinitro ortho secondary butyl phenol.
The cut stump sprays were applied to freshly cut stumps 1 to 5 inches in diameter.

TABLE 1—*Continued*

Species	Formulation	Treatment	Reaction
Chokecherry (*Prunus virginiana*)	ethyl ester 1250 ppm	foliage spray	II–IV
	sodium salt 1000 ppm	foliage spray	IV
	methyl ester 1665 ppm. in kerosene	foliage spray	II
	isopropyl ester 1500 ppm	foliage spray	III
	isopropyl ester 2000 ppm	foliage spray	III
	isopropyl ester 4000 ppm. in fuel oil	foliage spray	I–II
	methyl ester 1000 ppm	foliage spray	II–IV
	DNOSBP .05 lb. per gal. plus methyl ester 1665 ppm. in kerosene.	stem spray	II
	ammonium sulphamate	foliage spray	III
Dogwood (*Cornus alternifolia*)	methyl ester 1000 ppm	foliage spray	IV
Hawthorn (*Crateagus* sp.)	DNOSBP .05 lb. per gal. in kerosene	stem spray	II
	ethyl ester 1250 ppm	foliage spray	III–IV
	sodium salt 1000 ppm	foliage spray	IV
	methyl ester 1665 ppm. in kerosene	foliage spray	IV
	ammonium sulphamate	foliage spray	II
	methyl ester 4500 ppm. in fuel oil	cut stump spray	I–III
	methyl ester 1000 ppm	foliage spray	II
	ethyl ester 1250 ppm	foliage spray on fresh sprouts	II
Hazel (*Corylus cornuta*)	ammonium sulphamate	foliage spray	II
	ethyl ester 1250 ppm	foliage spray	I–II
	sodium salt 1000 ppm	foliage spray	I–III
	sodium salt plus $NaClO_3$	foliage spray	I–II
	DNOSBP .05 lb. per gal. in kerosene	foliage and stem spray	III
	DNOSBP .025 lb. per gal. plus methyl ester 1665 ppm. in kerosene.	foliage and stem spray	II
	methyl ester 1665 ppm. in kerosene	foliage spray	II
	methyl ester 3000 ppm	foliage spray	I
	methyl ester 1000 ppm	foliage spray	I
	methyl ester 4500 ppm. in kerosene	cut stump spray	I
	isopropyl ester 1500 ppm	foliage spray	I

All treatments made during the mid-season period July 1 to August 15. (1945-47).
Reaction types I, hypersensitive—II, sensitive—III, semi-tolerant—IV, tolerant.
All formulations are in water unless otherwise noted.
All formulations are of 2, 4-D unless otherwise noted.
The symbol DNOSBP refers to the toxicant dinitro ortho secondary butyl phenol.
The cut stump sprays were applied to freshly cut stumps 1 to 5 inches in diameter.

TABLE 1—*Continued*

Species	Formulation	Treatment	Reaction
Juneberry (*Amelanchier* sp.)	DNOSBP .05 lb. per gal. in kerosene	foliage and stem spray	III
	ethyl ester 1250 ppm	foliage spray	III
	sodium salt 1000 ppm	foliage spray	II–III
	methyl ester 1665 ppm. in kerosene	foliage spray	II
	ammonium sulphamate	foliage spray	I
Mt. maple (*Acer spicatum*)	methyl ester 1665 ppm. in kerosene	foliage spray	III
	methyl ester 1000 ppm	foliage spray	III–IV
	methyl ester 3000 ppm. in kerosene	foliage spray	III–IV
	ethyl ester 1250 ppm	foliage spray	IV
Pin cherry (*Prunus pensylvanica*)	sodium salt 1000 ppm	foliage spray	II
	ethyl ester 1250 ppm	foliage spray	II–III
	methyl ester 1665 ppm. in kerosene	foliage spray	I–III
	ammonium sulphamate	foliage spray	II
	DNOSBP .025 lb. per gal. plus 1665 ppm. methyl ester in kerosene.	stem and foliage spray	I
	methyl ester 4500 ppm. in kerosene	cut stump spray	I–III
	methyl ester 1000 ppm	foliage spray	III
	methyl ester 3000 ppm. in fuel oil	foliage spray	III
Red maple (*Acer rubrum*)	sodium salt 1000 ppm	foliage spray	IV
	ammonium sulphamate	foliage spray	II–III
	ammonium sulphamate	placed in holes in stem	II
	DNOSBP .05 lb. per gal. in kerosene	stem and foliage spray	II–IV
	DNOSBP .025 lb. per gal. plus 1665 ppm. methyl ester in kerosene.	stem and foliage spray	III
	DNOSBP .025 lb. per gal. plus 1665 ppm. methyl ester in kerosene.	cut stump spray	II
	methyl ester 4500 ppm. in kerosene	cut stump spray	I–II
	ethyl ester 1250 ppm	foliage spray	IV
	methyl ester 1665 ppm. in kerosene	foliage spray	IV
	methyl ester 3000 ppm. in kerosene	cut stump spray	II–III
	sodium salt 70% 2,4-D	powder placed in slits under bark	III–IV
	isopropyl ester 4000 ppm	foliage spray	III
	isopropyl ester 1500 ppm	foliage spray	III–IV
	isopropyl ester 4000 ppm. in fuel oil	foliage spray	III
	methyl ester 1000 ppm	foliage spray	IV

All treatments made during the mid-season period July 1 to August 15. (1945-47).
Reaction types I, hypersensitive—II, sensitive—III, semi-tolerant—IV, tolerant.
All formulations are in water unless otherwise noted.
All formulations are of 2, 4-D unless otherwise noted.
The symbol DNOSBP refers to the toxicant dinitro ortho secondary butyl phenol.
The cut stump sprays were applied to freshly cut stumps 1 to 5 inches in diameter.

TABLE 1—*Concluded*

Species	Formulation	Treatment	Reaction
Willow (*Salix* sp.)	sodium salt 1000 ppm	foliage spray	I–III
	ethyl ester 1250 ppm	foliage spray	I
	methyl ester 1665 ppm. in kerosene	foliage spray	I
	methyl ester 1000 ppm	foliage spray	II–III
	methyl ester 3000 ppm. in fuel oil	cut stump spray	IV
	DNOSBP .05 lb. per gal. in kerosene	stem and foliage spray	III
	ammonium sulphamate	foliage spray	I–II
Withe-rod (*Viburnum cassinoides*)	ethyl ester 1250 ppm	foliage spray	III
	methyl ester 1665 ppm. in kerosene	foliage spray	III
	sodium salt 1000 ppm	foliage spray	III
	DNOSBP .025 lb. per gal. plus 1665 ppm. methyl ester in kerosene.	stem and foliage spray	II–III
	DNOSBP .05 lb. per gal. in kerosene	stem and foliage spray	II–III

All treatments made during the mid-season period July 1 to August 15. (1945-47).
Reaction types I, hypersensitive—II, sensitive—III, semi-tolerant—IV, tolerant.
All formulations are in water unless otherwise noted.
All formulations are of 2, 4-D unless otherwise noted.
The symbol DNOSBP refers to the toxicant dinitro ortho secondary butyl phenol.
The cut stump sprays were applied to freshly cut stumps 1 to 5 inches in diameter.

The results with ammonium sulphamate were generally good. The effect of this treatment on all species is evident within a few days, the death of the leaves being followed by a drying out and death of the finer twigs. The amount of stem killed and the subsequent re-sprouting varies with the species and with other factors, some of which were not determined. Of the species tested, the hazel was the most susceptible to the treatment and chokecherry was probably the most resistant although it was usually killed to the ground. Unless the spraying was done late in the season all species except hazel usually re-sprouted the same season. Hazel re-sprouted the following year but with greatly reduced vigor and even at the end of the second season following treatment, the sprouting was only 30 percent or less of that obtained by cutting.

The ammate spray kills only leaves that it strikes, and dense clumps sometimes permit the inside leaves to escape the spray and only a partial kill results. It was noted that the effect of this spray was not as lethal to certain conifers as to the shrubs. This selective action resulted in the release of desirable conifers in a number of the clumps treated.

The results obtained with the various 2,4-D formulations are shown in the table. When consistent results were not obtained the range of results is given. In determining results, the amount of sprouting occurring the following year after treatment was considered, except for the 1947 treatments which are based on examinations of the roots. It should also be noted that the results are based upon only one application of the spray material. Considerable difference in the results with 2,4-D exist between the species and the formulations. Hazel was found to be one of the most sensitive species tested while the maples were the most resistant.

In most cases the sodium salt solutions were not as effective as the esters, but in several cases they gave good results especially when sodium chlorate had been added to the spray solution. The dry powder proved very effective on alder and aspen when placed under the bark.

The esters of 2,4-D seemed to give comparable results in most cases. Increased concentrations did not seem to be especially desirable except in the case of the cut stump sprays which in the case of red maple was most effective at a concentration of 4,500 p.p.m.

The placing of 2,4-D solutions in holes in the stems of aspen did not produce any marked results.

The phenol sprays resulted in the death of all leaves or needles struck by the spray. While the shrubs were apparently quickly killed they also sprouted quickly again in most cases. When the spray was used on the stem it was found that in some cases the cambium layer was killed by penetration of the toxic material through the bark. Species, age of stem and thickness of bark influenced this action. The aspens, pin cherry and mountain maple were most susceptible to stem sprays, while red maple, juneberry and hazel were more resistant. The results with aspen have been reported elsewhere (1).

DISCUSSION OF RESULTS

A consideration of the results obtained in the experimental work with chemical control methods indicates that a number of definite possibilities exists. Several of the species are responsive to the substances used, and with the development of better methods of application, the others may also be controlled in this manner.

We have noted that all of the species being considered sprout freely, and that cutting, therefore, does not usually constitute con-

trol. Likewise, the killing of the top with a chemical accomplished no more than cutting it. Shrubs can only be killed by destroying the tissues that give rise to the sprouts. Thus in estimating the value of a chemical for the control of shrubs, one must give primary consideration to the extent of re-growth.

The work with ammonium sulphamate indicated definite possibilities with respect to hazel. While sprouting occurred it was delayed and weak, and even at the end of 3 years, was not vigorous. The other species sprouted more abundantly and with greater vigor, indicating less advantage for the method. It was noted, too, that ammonium sulphamate had a more lasting effect than the contact sprays.

The use of 2,4-D materials seems to offer the greatest possibilities. The use of 2,4-D compounds for weed control is very recent and only a few authors have considered the woody species. Hamner and Tukey (2, 3) have reported the results of work with woody species. Among the species susceptible to 2,4-D were two of the species being treated here, chokecherry and willow.

Several factors apparently influence the reaction of a plant to 2,4-D. Many variations in the results of the experiments are due to the effect of influences which are not completely understood as yet. Differences in effect were noted which were apparently due to weather conditions, particularly temperature. Higher temperatures resulted in a speeding-up of the reaction and an increase in the severity of the reaction. Marth and Davis (4), in their work with certain herbaceous plants, found higher temperatures resulted in quicker killing while lower temperatures slowed up the action. Shrubs growing on dry, sandy soils also seemed to react more quickly to 2,4-D than those on moist, heavier soils. One cause for this difference may be that such sites having a heavier vegetative cover are cooler, and the shrubs are more likely to be shaded during part of the day.

No consistent difference was noted in those treatments which were followed by rain and those that were not. It may be that some of the poor results obtained with the water-soluble salt solutions should have been assigned to this cause.

The effectiveness of 2,4-D depends upon its conduction throughout the plant, the responses induced and the destruction of certain tissues. Inasmuch as the best results were obtained during July, after the most active growth period, but during the period of highest tem-

perature and greatest transpiration rate, it would seem that the effectiveness of the spray is associated with the existence of a water deficit in the plant and a consequent rapid transport of the chemical in the xylem elements. The greater effectiveness of 2,4-D on dry sites than on moist sites, as previously mentioned, is further evidence in this direction.

Hazel and willow were the only species showing evidence of carrying some 2,4-D effects over into the year following treatment. Sprouting was the least in those species which responded the most to 2,4-D, but there were many inconsistencies and more intensive work is needed dealing with the effects of 2,4-D upon the root tissues giving rise to sprouts.

Upon the basis of these experiments it seems that many shrubs will re-sprout following 2,4-D treatment. This sprouting will, however, be much less than that obtained with cutting, and a second treatment the next season should affect control on those species which can be controlled with 2,4-D.

The contact sprays containing DNOSBP, while resulting in an immediate killing of the leaves, did not seem to have much residual effect and the sprouting resembled that which follows cutting. When the spray was used, however, as a stem spray, those species that were susceptible proved to be much more seriously injured and in many cases were unable to re-sprout.

The spray containing 2,4-D and DNOSBP did not give superior results and, in fact, there was little evidence of any 2,4-D reaction when it was used as a leaf spray. It is assumed that this was due to the other toxicant killing the leaf tissue before the 2,4-D could be translocated.

At this time it seems that the use of a concentrated 2,4-D formulation as a cut stump spray on freshly cutover areas followed later in the season by a more dilute foliage spray will give the best control of most undesirable shrubs.

SUMMARY

Experiments with some chemical weed killers as a means of controlling several species of shrubs and trees indicated several possibilities.

Ammonium sulphamate was most effective on hazel. The other species usually sprouted strongly following treatment.

Sprays containing 2,4-D were the most promising of those tried. Even the most resistant species were susceptible to some applications. In general, the esters were more effective than the sodium salt. Concentrated solutions gave promise of preventing re-sprouting of some species when applied as fresh cut stump sprays.

The dinitro-phenolic contact sprays resulted in an immediate killing of the aerial portion of the shrubs, but sprouting was immediate and vigorous in many cases. When applied as a stem spray this substance was especially effective on aspen and pin cherry.

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APPLYING FERTILIZER THROUGH IRRIGATION WATER

By F. W. PEIKERT and R. L. COOK
SECTIONS OF AGRICULTURAL ENGINEERING AND SOIL SCIENCE

NITROGEN may well be applied through irrigation water. Most of the nitrogen fertilizers are readily soluble, and the chemistry of nitrogen in the soil is such that the idea of broadcasting the fertilizer in solution is theoretically sound. Potash fertilizers may also be applied satisfactorily through irrigation water, but it is probably desirable to apply only a small portion of the total quantity in this manner and the remainder in bands at planting time. Phosphorus is not adapted to application in water and, therefore, it follows that mixed commercial fertilizers containing phosphorus should not be applied in this manner.

It is the object of this article to show why the fertilizer nutrients vary in their adaptability to applications through irrigation water and discuss rates and methods of applications.

A COMPARISON OF THE MAJOR PLANT NUTRIENTS

The three major plant nutrients, nitrogen, phosphorus and potassium vary in the way they lend themselves to application through irrigation water. The variation is largely due to differences in chemical activity in the soil and to degree of solubility of the fertilizer materials. A brief discussion of the individual nutrients, as to how they exist in the soil and in the fertilizer bag, and what happens to them in the soil shows why they are not equally adapted to this manner of application.

Nitrogen Well Adapted to Application Through Irrigation Water

Most of the nitrogen exists in the soil in the form of organic matter. Soil microorganisms decompose the organic matter and release the nitrogen as ammonia. Other organisms change the ammonia to

ARTICLE 30-56

nitrate nitrogen, the form in which most plants prefer their nitrogen. If the form of organic matter in the soil is highly carbonaceous in nature, as straw or corn stover, the quantity of nitrogen contained is too low for the body needs of the organisms which bring about the decomposition. At such a time the organisms collect all that is available in the soil. This includes the nitrogen which was applied as fertilizer at the time the crop was planted. Thus, nitrogen applied at planting time may be entirely used up by soil organisms before the time comes when the crop actually needs it.

This was shown to be true in greenhouse experiments[1] in which a per acre application of 900 pounds of ammonium nitrate at planting time did not furnish sufficient nitrogen to nourish sugar beets until harvest. The starvation was indicated by tests made on the green tissue. In comparison, plants which had received the same quantity of nitrogen fertilizer in three applications, one at planting time and two later, were well supplied with nitrogen throughout the season. From the weight of the crop produced and the analysis of the beets, only 50 percent of the nitrogen could be accounted for where it was all applied early, while in the other case it was possible to account for about 70 percent of the quantity applied and the tests indicated some still available to the crop at harvest time. There seems little doubt but what most of the nitrogen not accounted for was used up by soil organisms as there was no leaching from the pots.

Some of the state experiment stations have reported good response from nitrogen fertilizer applied as a side-dressing when corn was 2 to 3 feet high but very little response when the fertilizer was applied at planting time or before. It is very likely that the nitrogen which was applied early in the season was either lost through leaching or was used by soil organisms before the corn had made sufficient growth to require the supplementary application.

Carolus[2] has reported that potatoes, at the Virginia Truck Experiment Station, required only 7 pounds of nitrogen an acre during the first 7 weeks of their growth period but during the next 5 weeks the crop used 53 pounds an acre. The logical time then to apply nitrogen for such a crop is during that period of rapid growth when the need for nitrogen is great. Irrigation water, of course, offers a convenient means of making such applications during midseason.

Without irrigation, midseason applications of soluble nitrogen fer-

[1]Soil Science Society of America Proceedings *11*: 298-304, 1946.

[2]American Potato Journal *14*: 141-153, 1937.

tilizer may be ineffective because the surface soil does not contain enough moisture to dissolve the nitrogen salt. Deep placement at that season is not recommended, because of the danger of injury to roots. Irrigation water therefore furnishes a good solution to this otherwise difficult problem.

Only soluble salts can be easily and efficiently applied through irrigation water. All of the three common nitrogen salts, ammonium sulfate, ammonium nitrate, and sodium nitrate are easily and completely soluble in water.

Dates as well as rates of application of nitrogen salts through irrigation water should vary with different soils and with crops. Perhaps one should always apply a small quantity of nitrogen at planting time, just in case rainfall is plentiful for a time and no irrigation is needed. Tests made on the soil and on the green plants along through the season should furnish worthwhile clues as to when nitrogen should be first placed in the irrigation water. With most crops it will be several weeks after planting, when vegetative growth becomes rapid. Forty to eighty pounds of nitrogen applied per acre during the rapid growth period should be sufficient for most crops. The smaller quantity would be contained in approximately 200 pounds of ammonium sulfate, 120 pounds of ammonium nitrate, or 240 pounds of sodium nitrate. If it is contemplated that the rapid growth period of the crop will last 6 weeks it is recommended that one-sixth of the total quantity of nitrogen be applied each week.

Potash at Planting Time and Through Irrigation Water

Potassium salts are largely soluble in water and the element does not readily form unavailable compounds in the soil, so it is easy and theoretically correct to apply potash fertilizer through irrigation water if desirable. However, there is probably little reason to recommend the method of application for this fertilizer except when additional applications are needed. Potassium does not leach readily and it is not used in large amounts by soil organisms, as is the case with nitrogen. Therefore, it is correct to apply all the potash at the time of planting or before. However, one may not be able to predict exactly the needs of a crop, so perhaps when irrigation is to be practiced it will be most economical to apply a medium quantity at planting time and more through irrigation water as tests indicate a need. The tests should be made regularly on the green plants.

As an illustration, if the planting time application of fertilizer is 1,000 pounds per acre of 2-16-8, about 130 pounds of 62-percent muriate of potash will be required to contain the same quantity of potassium. If after the initial planting time application, there is a need for more in the irrigation water an application of 22 pounds each week for 6 weeks would result in a doubling of the initial application.

Phosphorus Should Be Applied at Planting Time

Experiments conducted during recent years have shown that fertilizers containing phosphorus are much more efficient when applied in bands than when mixed with the soil after a broadcast application. The greater efficiency is largely due to the lesser contact between the fertilizer and the soil, which results in less fixation of the phosphorus into forms not available to plants. Application of phosphorus in solution would result in maximum contact between the phosphorus and the soil and, therefore, fixation of much of the phosphorus into very difficultly available forms.

Another reason why phosphorus cannot be applied efficiently through irrigation water is that the cheaper sources of phosphorus are not readily soluble. Prince and Tiedgens[1] of New Jersey found that much of the phosphate in mixed fertilizers could not be dissolved in water. Even at low concentrations (3 pounds in 50 gallons of water) over 50 percent of the phosphorus in some of the mixtures failed to dissolve. This low solubility of the phosphorus in mixed fertilizer is due to the fact that the phosphorus is supplied as superphosphate. If an attempt is made to apply superphosphate through irrigation water, the undissolved portion must be discarded or forced through the system in suspension. In order to force solid fertilizer through the sprinklers it would be necessary to grind it finer than is generally done and provide some agitation equipment to keep the material in suspension. Even with very finely ground fertilizer there would be serious danger of clogging the sprinklers. Soluble forms of phosphorus are too expensive as sources of phosphorus for large areas.

METHODS OF APPLYING THE FERTILIZER

When using a horizontal centrifugal pump, the most practical method of applying the fertilizer is to draw the solution through the

[1]New Jersey Agricultural Experiment Station, Circular 449, 1942.

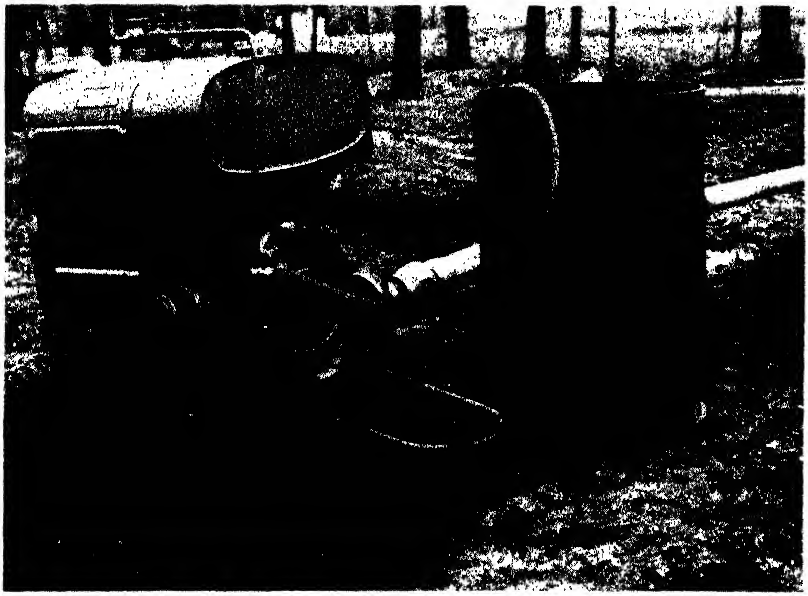


Fig. 1. A portable-type centrifugal pump equipped to apply fertilizer through irrigation water.

intake side while the pump is in operation. The fertilizer thereby enters the stream of water and thorough mixing occurs (Fig. 1).

To make this installation, a pipe fitting or short piece of pipe (1/4 inch or larger) is connected at a suitable place in the suction line of the pump. Many pumps have a plug that can be removed and a pipe can be screwed in its place. If that is not possible, the suction line may be drilled and tapped for the size pipe or fitting desired. Next, a shut-off valve is attached and, from the valve, a piece of garden hose about 6 feet in length run into a barrel or other container in which the fertilizer is dissolved. A 55-gallon oil barrel with one end open is usually suitable for this purpose. See Fig. 2 for the installation on one particular pump. The actual fittings required will depend, somewhat, on the size and location of the hole through which the fertilizer enters the pump.

To apply the fertilizer, the desired quantity is measured out and placed in a barrel with sufficient water so that all the fertilizer is thoroughly dissolved.

For any one setting of the irrigation pipe, it is desirable to first

run the water for 15 to 30 minutes. The valve is then opened a small amount so that the fertilizer is slowly drawn in with the stream of water and discharged through the sprinklers. As soon as the fertilizer solution is taken from the barrel, the valve should be closed. The proper opening of the valve is such that 10 to 15 minutes is required to take in the required amount of fertilizer. After the fertilizer has gone through the line, the sprinklers should be run at least an additional 10 minutes in order to wash all the material off the plants.

It is always a poor practice to irrigate at such a high precipitation rate that the water will run off the surface. When applying fertilizer, it is even more important to watch this point as it is impossible to get uniform fertilizer application if the water is allowed to run to the low places.

Before starting the pump, the suction line must be tightly closed. If there are air leaks in the valve or at other points in the suction line, it might be impossible to prime the pump.

When using a deep-well turbine pump, the fertilizer solution must be induced into the irrigation water by other means than that described above. One method that is being used satisfactorily is to tap the pipe line on the discharge side of the pump and again install a

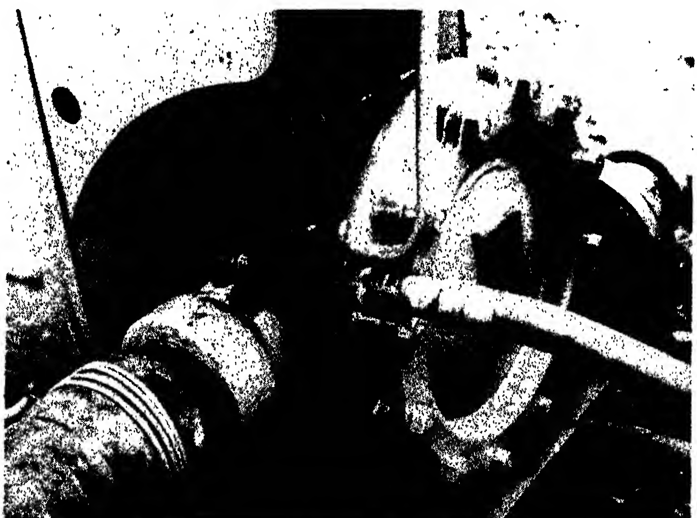


Fig. 2. Fittings used to introduce the fertilizer solution into the intake side of a centrifugal pump.

valve and suitable piping. The fertilizer solution can then be foroed into the stream of water under appreciably higher pressure than delivered by the irrigation pump. Some are using a regular spray pump for this purpose and mixing the fertilizer solution in the tank of the sprayer.

QUANTITIES OF FERTILIZER TO APPLY

After deciding on the per acre rate of fertilizer application for one irrigation, the number of pounds needed for a setting of the sprinklers can be determined from Table 1.

Ammonium sulfate is the least soluble of the three nitrogen fertilizers previously mentioned. It is soluble to the extent of 280 pounds in 50 gallons of water. The same amount of water will dissolve 108 pounds of potassium chloride. If great quantities of both potassium and nitrogen fertilizers are applied, owing to high rates or large areas per sprinkler setting, it is desirable to dissolve the fertilizers separately. When combined at high concentrations, these two materials react to form potassium sulfate which is much less soluble.

Fertilizers dissolve quite readily at low concentrations but as the saturation point is approached, considerable stirring is necessary. In such cases, it might be desirable to provide a mixing tank having a larger volume than a barrel.

TABLE 1—*Pounds of fertilizer to use for each setting of a sprinkler line*

Length of line (rods)	Distance line moved per setting (feet)	Rate of fertilizer application (lb. per acre)				
		20	40	60	80	100
20	40	6	12	18	24	30
	60	9	18	27	36	45
	80	12	24	36	48	60
40	40	12	24	36	48	60
	60	18	36	54	72	90
	80	24	48	72	96	120
60	40	18	36	54	72	90
	60	27	54	81	108	135
	80	36	72	108	144	180
80	40	24	48	72	96	120
	60	36	72	108	144	180
	80	48	96	144	192	240

SUMMARY

The application of fertilizer through irrigation water is another method which is theoretically sound for nitrogen and potash but not for phosphorus. It seems to be an especially desirable method for applying nitrogen during midseason. It is suggested that a little nitrogen, all the phosphorus and most of the potassium be applied in bands at planting time and that supplementary nitrogen and potassium be applied when tests or observations indicate a need.

Fertilizer should be dissolved in water in a barrel or other suitable container and introduced into the pipe line while irrigation water is being applied. If the pump is of the centrifugal type, the solution is taken into the intake line. In the case of a deep-well turbine, the solution must be forced into the discharge line under higher pressure than that developed by the pump.

NITROACETATE AND NITRODITHIOACETATES AS POTATO SPRAYS

By J. H. MUNCIE and W. F. MOROFSKY
SECTIONS OF BOTANY ADD PLANT PATHOLOGY, AND ENTOMOLOGY

DURING the last few years many new materials have been developed to replace bordeaux mixture as a spray material. Among these may be mentioned the low-solubility or fixed coppers and more recently the carbamates. While many of these materials have given good results as potato sprays, the search still goes on for even better fungicides.

Preliminary field tests were made on potatoes in 1946 of two new materials, the nitrodithioacetates of zinc and copper, to which DDT[1] or BHC[2] were added as insecticides. These materials showed sufficient promise to warrant further tests in 1947. Results of the tests of the nitrodithioacetates of zinc and copper and of copper nitroacetate are here given as a progress report.

MATERIALS AND METHODS

The new materials supplied by General Chemical Co. will be referred to by the following numbers; 308, copper nitrodithioacetate, 629 zinc nitrodithioacetate and 632 copper nitroacetate. They contained respectively 32.3 percent copper, 33.8 percent zinc and 38.3 percent copper. These were used with either DDT or BHC in control of potato insects.

Fixed copper and bordeaux mixture combined with DDT and BHC and DDT alone were used as checks against the new materials.

The plats planted June 15 to Menominee variety, consisting of four rows 180 feet long, were randomized and replicated three times. Two harvestings were made of the two center rows, 40 feet long. The plats were sprayed at intervals of 10 days beginning July 15,

[1]Dichlorodiphenyltrichlor ethane.
[2]Benzene hexachloride.

ARTICLE 30-57

TABLE 1—*Results with nitro-nitrodithioacetate potato sprays, Lake City 1947, Menominee variety*

Materials and dosage*		Bushels per acre U. S. No. 1**	Total insect counts for season***		Sept. 15
			Leaf hoppers	Flea beetles	Early blight percent infection
†629–308–DDT	1–1–2–100	243.8	12	4	1.0
629–308–BHC	1–1–1–100	246.1	41	12	1.0
††629–632–DDT	1–1–2–100	262.3	23	2	1.5
629–632–BHC	1–1–1–100	232.4	44	8	1.0
629–DDT	2–2–100	256.5	27	9	1.0
629–BHC	2–1–100	241.0	60	7	1.0
308–DDT	2–2–100	254.9	18	1	1.0
632–DDT	2–2–100	255.9	22	1	1.0
Copper–DDT–BHC	3–½–½–100	216.9	14	1	5 0
Genicop	4–100	215 5	15	0	5.0
Bordeaux–DDT	8–4–11/2–100	192.2	16	0	5.0
Bordeaux–BHC	8–4–3–100	242.1	51	3	5.0
DDT alone	1½–100	177.1	13	2	5.0
Check–no spray		248.5	87	107	15.0

*One-half pound of "Filmfast" added to each 100 gallons of experimental sprays.
**Least significant difference—42.4 bushels at 5%: 56.4 bushels at 1%.
***Total count of insects from five sweeps 2–4–6 and 8 days after each of 7 spray applications.
†629 zinc nitrodithioacetate.
308 copper nitrodithioacetate.
††632 copper nitroacetate.

with 7 applications being made before the killing frost of September 23.

No late blight was present. Readings of early blight infection, which was light, were made August 15 and September 5. Insect collections were made from each plat 2, 4, 6 and 8 days after each of the seven spray applications. Insect counts were made from five complete sweeps at each collection. In Table 1, the potato leaf hopper, six-spotted-leaf hopper and others are included under a single heading. Potato insects were of minor importance, and only six Colorado potato beetles were collected from all the plats during the entire season.

The latter part of the season was hot and dry, water being furnished by five irrigations with a whirling sprinkler system delivering approximately one acre-inch of water per hour.

RESULTS

Highest yield of U. S. No. 1 potatoes was obtained from the plat sprayed with a combination of zinc nitrodithioacetate and copper nitroacetate with DDT as insecticide. However, plats receiving any one of the new materials whether used alone or as a combined fungi-

cide had yields significantly higher than those plats sprayed with bordeaux mixture, a fixed copper, Genicop or the insecticide DDT alone. Substitution of BHC in place of DDT with these materials in every case resulted in reduced control of leaf hoppers while effect on flea beetle control was variable.

The combination of DDT and BHC with a fixed copper apparently had no additive effect in reducing either leaf hopper or flea beetle populations below that produced by DDT alone.

Increase in yield of the plats receiving bordeaux plus BHC over those receiving the same material plus DDT cannot be explained on the basis of results obtained from the plats getting these insecticides alone or in combination with other fungicides.

CONCLUSIONS

From these results it appears that the nitrodithioacetates of copper and zinc and copper nitroacetate show considerable promise as potato sprays. Certainly further tests are warranted, especially with other potato varieties and under conditions of heavier insect infestation and incidence of fungus leaf diseases. Although early blight was not severe, these materials held the disease in check better than bordeaux mixture with no decrease in yield. Although insect infestation also was light, the use of benzene hexachloride instead of DDT resulted in lowered insect control, particularly potato leaf hoppers, and in most cases decreased yields of potatoes.

EFFECT OF 2,4-DICHLOROPHENOXYACETIC ACID ON OATS AND BARLEY VARIETIES

By B. H. GRIGSBY and BOYD C. CHURCHILL
SECTIONS OF BOTANY AND PLANT PATHOLOGY, AND FARM CROPS

EXPERIMENTS with 2,4-D on small grains in Michigan and in other states have indicated the possibilities of its use as a selective spray for these crops. While the data point out the value and possibilities of 2,4-D, details regarding its range of effectiveness under different conditions, proper rates of application, and effect upon the crops are still partially or entirely unsolved.

To secure further data on these problems, several varieties of oats, barley, flax, and corn hybrids were planted in 1947 on experimental plats at East Lansing. The field was rather low and in the spring, very wet. Rye, grown as a winter cover crop, had to be plowed down before plantings could be made. All plantings were made after June 1, too late for commercial seedings of oats, barley and flax in this vicinity. However, the authors believed that much could be learned even though yields might be very low, since yields were to be taken only on one variety of oats and one variety of barley. The information presented here pertains only to results with oats and barley.

Spraying was done with a "Jeep"-mounted sprayer equipped with a 50-gallon spray tank, power take-off pump and boom with flat fan-type nozzles. All plats were sprayed crosswise of the seeding. Plats from which yields were taken were drill-width wide and in triplicate. Other plats consisted of a single planting of five rows of each variety.

Three rates of application were made of the sodium salt and ester of 2,4-D when the grain was about 6 inches high. At the same time, plats were sprayed with Dow Selective Weed Killer, a dinitro compound, at two rates. A check plat was left unsprayed for comparison. At a later date (after heading) an additional plat was sprayed with the ester of 2,4-D at the rate of 1¼ pound of actual 2,4-D acid per acre. Germination tests were made of the cleaned seed harvested from the various plats.

ARTICLE 30-58

TABLE 1—*Effect of selective sprays at varying rates and dates upon yield of oats and barley in percentage of check yield*

Treatment	Percent of check*		Treatment	Percent of check*	
	Barley	Oats		Barley	Oats
Sodium salt, light rate	58.9	48.6	Ester, heavy	55.4	67.6
Sodium salt, medium	67.8	62.4	Dow Selective, light	100.9	94.9
Sodium salt, heavy	55.4	55.8	Check	100.0	100.0
Ester, light	42.0	78.3	Dow Selective, medium	75.0	91.3
Ester, medium	67.8	83.3	Ester, light (after heading)	82.0	87.7

*Yield per acre of check: barley—13.6 bushels per acre, oats—25.1 bushels per acre.

RESULTS

Table 1 shows the yields, in percentages of the check, for Bay barley and an unnamed selection of oats, No. 3909.

The plats contained a number of weed species and volunteer plants of red, alsike, and ladino clovers. The clovers survived only in the check plats and in those plats sprayed with Dow Selective Weed Killer. Weeds were not plentiful enough to cause any great reduction in yield of the grain. Not all weed species were killed. However, wild mustard and common ragweed, the predominating species, were killed by all sprays at all rates.

While too much emphasis should not be placed upon the yields, it seems significant that check plat yields were highest. Yields of oats were not affected by Dow Selective Weed Killer at either rate, and yield of barley was not affected by this material at the lighter rate. All other rates and materials reduced yield of the grain under conditions of this experiment.

Table 2 gives the percentage germination of the nine varieties of oats and three varieties of barley tested.

Germination was high for all varieties of barley and for all but two varieties of oats tested. Germination of Bond X, when sprayed with either the ester or sodium salt of 2,4-D, apparently was lowered somewhat from that of the check and the plats sprayed with Dow Selective Weed Killer. Results with Benton oats were irregular but germination in some instances apparently was reduced by the spray treatment.

TABLE 2—*Effect of selective sprays upon seed germination of oats and barley harvested from field sprayed plots*

Varieties	Treatments									
	2, 4-D* Sodium salt			2, 4-D* Ester			Dow Selective Weed Killer		2, 4-D Ester late	Check
	¾ lb. light	1½ lb. medium	2 lb. heavy	¾ lb. light	1½ lb. medium	2 lb. heavy	2 pints per acre	3 pints per acre		
Bay barley	99.6	100.0	99.9	94.3	99.5	99.7	96.2	97.5	98.9	96.3
Spartan barley	94.5	93.5	85.5	95.0	99.5	98.5	98.5	98.0	98.5	92.0
Wisconsin 38 barley	99.0	93.0	97.2	99.5	99.4	98.5	99.0	99.5	99.5	99.5
Mindo oats	98.5	97.0	98.7	96.5	99.0	99.0	100.0	99.0	98.5	99.0
3909 oats	97.4	98.0	93.7	97.5	97.2	92.2	97.2	97.3	97.7	98.9
Benton oats	79.5	69.0	96.0	97.5	90.5	95.5	76.0	90.5	90.0	96.0
Bond X oats	85.5	85.0	79.0	81.0	84.0	85.5	90.0	94.0	85.5	97.5
Clinton oats	91.0	89.5	89.0	91.5	89.5	93.0	90.5	97.5	96.5	96.0
Eaton oats	98.5	94.0	92.5	99.0	99.0	96.0	94.0	99.0	94.5	96.5
Forvic oats	96.0	99.0	99.5	99.5	98.0	97.5	98.5	99.5	99.0	99.5
Huron oats	97.5	93.5	96.0	96.0	98.5	90.0	98.5	100.0	99.0	99.0
Marion oats	99.0	94.0	99.0	99.5	96.0	97.0	99.0	98.5	98.0	....
Vicland oats	100.0	97.0	100.0	96.5	95.5	91.5	99.4	99.0	98.5	100.0

*2, 4-D equivalent as pounds of 2, 4-D acid per acre in the form of sodium salt or butyl ester.

SUMMARY

1. Oats and barley, sprayed when the plants were 4-6 inches in height, did not show any evidence of injury to vegetative tissue at the rates of ¾, 1½ and 2 pounds 2,4-D acid equivalent per acre.

2. Ragweed, mustard, yellow rocket and rough pigweed were killed by all chemicals at all rates used in these trials.

3. Weed grasses and smartweed were not killed by any of the treatments.

4. Seedling clover was killed by all 2,4-D treatments. Dow Selective Weed Killer did not kill the clover.

5. Germination of barley was not reduced by 2,4-D nor by Dow Selective Weed Killer.

6. Germination of two varieties of oats was somewhat reduced by spraying with 2,4-D. Benton oats were less severely affected than the variety Bond X. These results indicate that there may be varietal differences in the response of small grains to 2,4-D and that testing of all commercially grown varieties is needed before recommendations for spraying these crops can be made. Such tests are proposed for the 1948 season.

SOME CHEMICAL AND PHYSICAL PROPERTIES OF DAIRY CLEANERS

By P. S. LUCAS
SECTION OF DAIRY

THE VALUE of any dairy detergent depends upon its specific physical and chemical properties. The cleaning problems of a dairy products plant, in many instances require different end results and, in some cases, the piece of equipment to be cleaned may not lend itself to harsher or gentler treatment than other pieces of equipment. Some pieces of equipment come into the plant in much worse condition than others. In other cases, the pieces to be washed are so numerous as to require rapid machine action while in some, hand cleaning is required. There is, for instance, the milk bottle which will endure harsher treatment than the milk can or tinned copper surface. Painted surfaces and hand-cleaned materials require the use of a cleaner mild in action. Floors, because of the type of soil, usually require special cleaners. For those reasons, the statement is often made that no one cleaner can answer all purposes in the plant.

Of cleansers used in dairy plants, soaps cannot be employed on equipment coming into contact with milk because of the film they leave and because of their expense. Owing to the increasing amount of attention now being given this subject, new types of detergents are being developed and introduced at very frequent intervals. These vary radically from each other in the means by which they accomplish detergency. Among these products are the wetting agents. Washing powders placed on the market under brand names are usually mixtures of these many detergents selected to add their contribution of properties to the trade marked cleaner. Similarly, home-made mixtures may be used to accomplish the same results. It is for the purpose of evaluating some of these properties that this article has been prepared. It should be remembered that these mixtures, whether compounded commercially, or by the dairy plant, vary necessarily in their economy, speed of action, availability of basic products, and the usage to which the product is to be put. The usage

ARTICLE 30-59

to which the product is put depends upon its effect on metal, glass, painted surfaces, tile and cement, the type of soil to be removed, whether for hand or machine washing, and type of washer such as soaker or brush-type bottle washers. If the user knows the properties of the ingredients of a mixture he may be able to select those types best adapted to the purpose of the cleaner.

The earliest cleaners used were the moderately harsh alkaline types and caustic soda for milk bottle washing. Use of these two was followed by a mixture of soda ash with bicarbonate of soda which was an advancement but had its disadvantages. This was followed by the introduction of trisodiumphosphate, followed by the introduction of such products as sodium metasilicate, the complex phosphates, weak acids, sodium aluminate, and the wetting agents. Newest of the cleaning agents are the quaternary ammonium compounds, the properties of which have not, at this date, been completely investigated. The dairy plant manager, in many cases; has become confused by the new data made available through study of these new products. In general, however, the simpler facts may be well understood by the user and may be intelligently applied either to the selection of the proper detergent or in the mixing of basic materials for preparation of a cleaner for a special purpose.

CLEANERS VARY GREATLY IN PROPERTIES

So far as this report is concerned, several cleaners have been selected. Many contain basic materials used in cleaners and commercial combinations. They range in reaction from acid to neutral to highly alkaline. A few have been very highly buffered, and an effort has been made to measure the amount of buffering by continuous neutralization (Table 3). An examination of the tables which follow will show, as would sales, that the trend has been away from the highly buffered combinations and from excessive alkalinity to solutions more nearly neutral, which the use of wetting agents have made possible. This has been made possible by the ability of the wetting agent to loosen oily films without resorting to the more drastic methods of saponification and emulsification. While it has not been definitely proved, it might be assumed that action of the wetting agents would result in the formation of less milk- and waterstone.

In Table 1 shown below, the results are given of titrations made of each cleaner in strength of 0.5 percent in neutral distilled water.

TABLE 1—*Chemical reaction and pH of 0.5-percent solutions (10-ml. portions used)*

No.	Product	Ml. to phenol-phthalein	Ml. to methyl orange	pH
1	Mikro San	0.75	....	3.11
2	Dolco Tilebrite	0.7	....	2.5
3	Nacconol N.R	0.0	0.0	6.76
4	Aerosol O.T. 100	0 0	0.06	6.5
5	Calgon	0.0	1.00	7.31
6	Kleer-Mor	0.28	0.58	9.33
7	Wyandotte Cleaner	2.34	4.40	9.62
8	Wyandotte Detergent	0.38	0.75	9.65
9	Solvay Super Cleaner	2.24	4.84	9.79
10	Solvay No. 600	2.44	3.55	10.38
11	Mathieson Nufos	2.97	2.82	10.67
12	Diversey Dumore	2.90	3.22	10.72
13	Diversey Diversol	0.85	....	11.01
14	Solvay Milkstone Remover	2.51	1.97	11.19
15	Trisodiumphosphate	1.52	1.55	11.31
16	Diversey Novex	4.89	3.63	11.46
17	Calgonite	1.55	1.57	11.50
18	Metasilicate (Metso)	4.46	0.31	11.72
19	Alkali Special	12.06	0.22	12.43
20	Sodium Aluminate	4.98	....	11.00
21	Neo Suds	1.20	2.85	9.40
22	F 100	1.60	1.98	11.09
23	Pyramid	1.94	2.58	9.84
24	Klenzade "CBS"	.90	3.80	10.40
25	Wyandotte G.L.X	2.9	6.1	10.78
26	Calglo	....	0.5	7.07
27	Klenzade Super Six	1.4	3.1	11.28
28	Solvay No. 800	2.2	5.6	9.10
29	Mathieson Briquets (Old Style)	3.0	5.7	11.09
30	Clenitol	....	1.0	7.55
31	Tetraphosphate	.3	2.0	8.35
32	Tetratripolyphosphate	.7	3.3	9.29
33	Tetrasodium pyrophosphate	1.4	4.5	9.94
34	Minn. U. Formula No. 1	3.6	4.6	11.77
35	Minn. U. Formula No. 2	2.4	3.85	11.30
36	Special Formula No. 1	2.4	3.6	11.51
37	Soda ash	4.2	8.5	10.91
38	Wyandotte Can Wash	3.75	6.8	10.99
39	Klenzade Can Wash	3.3	6.9	11.21

A 10-ml. portion of each was titrated against either tenth-normal hydrochloric acid or sodium hydroxide, and each was tested for pH. Titration results were recorded with two indicators: phenolphthalein and methyl orange. The amount (in ml.) of titrating agent required to neutralize, using phenolphthalein as the indicator indicates the amount required to neutralize all of the caustic, plus one-half of the sodium carbonate or soda ash, but none of the bicarbonate that might be present. The column headed "methyl orange" represents the amount required to neutralize the remaining half of any soda ash as well as all the bicarbonate originally present. Doubling this latter reading, therefore, gives the total soda ash plus sodium bicarbonate value. The total of both readings would give the total alkalinity. It is real-

ized that the presence of other basic detergents such as phosphates and silicates may interfere with such titrations, in which case the procedure must be modified.

These data, secured as described in the paragraph above, show the relative alkalinity of the detergents mentioned. Higher alkalinities may be used on equipment which is resistant to the action of strong alkalies, such as glass. Highly alkaline detergents may not safely be used on metals or in washing requiring hand cleaning. Strong alkalies favor the formation of milkstone and waterstone. The occasional use of acid cleaners has a tendency to remove such stone. In preparing a washing agent for the cleaning of metals or for hand washing, therefore, the user should select powders not possessing too high alkalinity.

The acid-base cleaners and the two wetting agents obviously would contain no carbonates. The first two mentioned are but weakly acid, and the second two are neutral, as is No. 5 which is sodium metasilicate. Five cleaners, numbers 7, 9, 10, 12, and 16 carry relatively large quantities of the buffer sodium bicarbonate. As shown previously, when a washing powder mixture contains only soda ash and bicarbonate, these act to hold the pH or alkalinity at a constant level of strength until the buffer is used up. The chief value of a buffer in a washing powder, however, is for use in hand washing and for the farm. Where machine washing of bottles is practiced, the stronger alkalies will clean more thoroughly. The column headed "pH" has been arranged for the first 18 samples largely in order of ascending values. Those values below 6.8 represent acid reaction and those above that value, alkaline reaction. Values greater than 12 for pH are of little use since the range of error is so great at that degree of alkalinity. It is assumed that that of special alkalines used in bottle washing will range from 12.0 to 12.6. In general, the harshness of the effect of cleaners increases with an increase in pH. A notable exception may be seen in the case of sodium metasilicate in its action on metals. It is difficult to explain why this is so, but a logical explanation seems to be that it forms a protective film of molecular thickness on the wall of the utensil. Another explanation might be the presence in the cleaner of an inhibiting agent such as sodium aluminate which acts as a buffer. When sodium metasilicate was used alone in a mechanical milk bottle washer, the gears became tightened to such an extent that the chains were broken. Presumably this was due to its poor lubricating properties. When used to no greater ex-

tent than 30 percent of the cleaner used, the results were satisfactory. When special alkalies were used in amounts greater than 3 percent, the tendency was to soften and damage the glass of milk bottles as well as to bleach the colors in any pyroglaze letters on the wall of the bottle. A 4-percent caustic solution had this effect upon glass milk bottles and it resulted also in saponification of any butterfat present. Such soap caused excessive foaming and difficult rinsing because of the soapy film left. The higher the temperature of the washing solution, the greater was this effect. A 3-percent solution of caustic possesses sufficient sanitizing powers and a 2½-percent solution is sufficient if a chlorine rinse is used on the bottles.

TABLE 2—*du Nuoy Tensiometer tests of 0.5-percent solution*

No.	Product	Dynes at 72° F.	Dynes at 145° F.
1	Mikro San	35.6	30.0
2	Dolco Tilebrite	69.9	67.5
3	Nacconol N.R	33.7	32.2
4	Aerosol O.T. 100	29.6	28.5
5	Calgon	72.7	70.0
6	Kleer-Mor	31.6	30.2
7	Wyandotte Cleaner	71.2	67.2
8	Wyandotte Detergent	26.1	25.6
9	Solvay Super Cleaner	71.3	62.5
10	Solvay No. 600	32.9	30.0
11	Mathieson Nufos	....	....
12	Diversey Dumore	36.7	32.9
13	Diversey Diversol	71.4	68.4
14	Solvay Milkstone Remover	66.4	63.6
15	Trisodiumphosphate	63.7	68.7
16	Diversey Novex	71.0	51.6
17	Calgonite	67.1	58.9
18	Metasilicate (Metso)	71.7	67.0
19	Alkali Special	60.4	55.6
20	Sodium Aluminate	73.0	66.1
21	Neo Suds	32.7	31.2
22	F 100	38.5	33.0
23	Pyramid	34.6	31.3
24	Klenzade "CBS"	30.8	30.2
25	Wyandotte G.L.X	34.5	31.7
26	Calglo	35.5	29.5
27	Klenzade Super Six	40.9	35.9
28	Solvay No. 800	41.5	35.1
29	Mathieson Briquets (Old Style)	71.0	66.8
30	Clenitol	32.5	31.2
31	Tetraphosphate	55.5	51.5
32	Tetratripolyphosphate	69.6	55.9
33	Tetrasodium pyrophosphate	66.0	50.9
34	Minn. U. Formula No. 1	34.6	31.9
35	Minn. U. Formula No. 2	34.5	31.5
36	Special Formula No. 1	40.8	35.8
37	Soda ash	53.7	58.0
38	Wyandotte Can Wash	63.0	48.8
39	Klenzade Can Wash	34.7	31.0

SURFACE TENSION

Wetting agents, especially, among dairy detergents have the power of reducing surface tension and herein lies their value. If used alone, they cause excessive foaming in machines where the agitation of the cleaning solution is violent. Used alone their strength is rapidly dissipated also by the dairy products clinging to the sides of dairy containers.

Surface tension may be measured by means of a du Nuoy tensiometer and the results tabulated in Table 2 were so obtained. For these a 0.5-percent solution was prepared and determinations made at 72° F. and 145° F. Since washing is done at nearer the latter temperature, the latter values should be more significant in rating the surface tension breaking powers of the detergent.

The lower the tensiometer readings the greater is the power of the cleaner to reduce surface tension. Values below 40 show the considerable employment of surface tension reducing chemicals in the cleaner. Many modern cleaners make great use of such agents together with soil removing agents.

BUFFER ACTION

Several 1-percent solutions of cleaners used were checked for maintenance of strength, as recorded by the pH test after the addition of 1-ml. portion of tenth-normal neutralizer. The purpose has been to check the degree of buffer action after each such addition. The differences in the results has been so great that the break in strength cannot be shown in graphs. The figures are given in Table 3.

Those cleaners previously mentioned as containing sodium bicarbonate are shown to be heavily buffered. This is a desirable characteristic, especially for those used in hand washing since the sodium carbonate, by feeding sodium ions into the mixture, maintains a constant strength; therefore, uniform washing results until the strength of the buffer begins to fail. With a washing powder not buffered, the strength is gradually dissipated from the start of the operation and it is reasonable to expect that uniform results will not be obtained unless the solution is constantly reinforced with new cleaner. On the other hand, it is not important to give much weight to the buffering of a solution since the carbonate cleaners are not, at the present time, especially

TABLE 3—*Dilution (ml.) required to reduce a 1.0-percent solution to pH 11, 10, 9, and 8*

No.	Product	From pH	Ml. 0.1039 N. HCL to reduce pH to:			
			11	10	9	8
1	Mikro San	3.11	....	....	....	....
2	Dolco Tilebrite	2.5	....	....	....	....
3	Nacconol N.R.	6.76	....	....	....	....
4	Aerosol O.T. 100	6.5	....	....	....	....
5	Calgon	7.43	....	....	....	....
6	Kleer-Mor	9.61	....	....	3	5
7	Wyandotte Cleaner	9.80	....	....	16	22
8	Wyandotte Detergent	9.75	....	....	14	20
9	Solvay Super Cleaner	9.72	....	....	16	25
10	Solvay No. 600	10.84	....	8	19	25
11	Mathieson Nufos	10.84	....	10	25	31
12	Diversey Dumore	11.21	5	14.5	27	32
13	Diversey Diversol	11.31	5	9	10	11
14	Solvay Milkstone Remover	11.30	7	14	21	23
15	Trisodiumphosphate	11.61	11	15	17	19
16	Diversey Novex	11.76	13	24	39	44
17	Calgonite	11.45	10	15	16	17
18	Metasilicate (Metso)	11.83	19	27	37	42
19	Alkali Special	12.64	111	115	116	116.5
20	Sodium Aluminate	11.51	3	16	35	40
21	Neo Suds	9.65	....	....	7	11
22	F 100	11.45	6	10.5	14	15.5
23	Pyramid	10.15	....	3	15	20.5
24	Klenzade "CBS"	11.2	1	7	12	20
25	Wyandotte G.L.X	11.2	2	11	25	29
26	Calglo	7.0	....	....	....	....
27	Klenzade Super Six	11.5	7	13.5	16	21
28	Solvay No. 800	10.05	....	1	16	20
29	Mathieson Briquets (Old Style)	12.1	7	18	29	32.5
30	Clenitol	7.46	....	....	....	....
31	Tetraphosphate	8.0	....	....	....	....
32	Tetratripolyphosphate	9.4	....	....	1	6
33	Tetrasodium pyrophosphate	10.06	....	....	2	11
34	Minn. U. Formula No. 1	11.85	14	23	33	38
35	Minn. U. Formula No. 2	11.5	1	7	14.5	19
36	Special Formula No. 1	11.62	4	10	20	22
37	Soda ash	10.72	....	11	34	41
38	Wyandotte Can Wash	11.15	1	12	23	25.5
39	Klenzade Can Wash	11.9	7	24	36	43

popular, because of spotting of equipment on drying, difficulty in rinsing, and their uncertain detergency powers.

In a general way, any plant wishing to make up its own cleaner could very well select an acid cleaner for use at weekly or bi-weekly intervals to remove milkstone. If the powder used is to be mixed in the plant, cleaning compounds for hand and metal washing, should contain an alkalinity no greater than 10.6 percent. For bottle washing, the cleaner should carry sufficient chemical to soften the water, and, in addition, sufficient alkali to make up a 3-percent solution. The more nearly neutral the washing powder, the gentler will be its effect

upon metals, especially tin and aluminum. When, in the past, a considerable alkalinity has been thought necessary for proper cleaning, the addition of wetting agents to the product will considerably reduce the necessity for it. While there are hundreds of wetting agents, these are by no means of equal value in dairy cleaning. A sufficient number, however, are adapted to this type of detergent action, so that selection is possible.

These values as buffers are given in Table 3.

Perhaps more logical compounding of dairy cleaners may be done, making use of the chemical's particular properties as recorded in the tables.

PACKING HOUSE TRIALS TO REDUCE PEACH-ROT

By H. A. CARDINELL and A. E. MITCHELL[1]
SECTION OF HORTICULTURE

"In New York City, crates of southern peaches amounting to over 250 cars a year are sold below the market because they do not meet the usual quality requirements of the trade. Some of these peaches have brown rot, some are moldy, some are green or overripe; a large number are bruised. These conditions are among the commoner causes of sale at a mark-down price."

EXCEPT FOR the fact that the foregoing statement was published in 1929 as a joint study between the U. S. Department of Agriculture and the New Jersey State Agricultural Experiment Station,[2] it could apply to many states, many cities and many years. Those factors continue to plague the fresh peach market. The season of 1947 was no exception.

The severe outbreak of brown-rot in many Michigan orchards in 1947, resulting in the failure of most spray schedules to cope with it, should not soon be forgotten by growers, shippers and receivers of last year's peach crop. The expected carry-over of brown-rot inoculum in Michigan orchards gives added interest to results of the treatments used last season to improve the market quality of Michigan peaches. It is thought that a brief report of a process named "Stericooling" by the manufacturer, and tried last season for the first time in Michigan, would be of interest to the perishable produce industry. The commercial test in Michigan was entirely with peaches. Further trials contemplated for 1948 will include certain vegetables and fruits.

[1]Acknowledgment: Appreciation is hereby expressed to Dr. C. G. Barr and others of the John Bean Division of Food Machinery Corporation, officers and personnel of the Millburg Growers Exchange and the Sodus Fruit Exchange for the opportunity to make these preliminary tests; to the Michigan Ice Industries Association and its secretary, Mr. William J. Campbell; to the Brown Ice and Coal Company of St. Joseph for ice and ice handling equipment; to Dr. M. E. Cravens, Jr., of the Department of Economics for lending a helping hand in many a rush period and for supplying Consumer Report cards on distant shipments of treated packages; and to the authors' colleagues in the Department of Horticulture for valuable suggestions.

[2]Factors Affecting the Price of Peaches in the New York City Market. Harry S. Kantor. U. S. D. A. Tech. Bull. 115, p. 24, Apr. 1929.

ARTICLE 30-60

The Millburg Growers Exchange treated about 7,000 packed bushels of Halehaven and Elberta peaches in an "F. M. C. Steri-cooler". This required 45.5 tons of artificial ice, or about 13 pounds per bushel of peaches, to refrigerate to an average fruit temperature of about 42° F.

EQUIPMENT AND METHODS USED IN HYDROCOOLING

By previous arrangement between the John Bean Division of the Food Machinery Corporation, and the Millburg Growers Exchange, the Section of Horticulture had an opportunity to cooperate in testing a piece of equipment and a method new to Michigan. It consisted of a tank, 25 by 8 feet, containing some 2,000 gallons of ice

Fig. 1. Wooden boxes "faced and filled" with peaches are shown coming out of the machine after being hydrocooled with ice water containing a chlorine-type germicide, "Hypo-Clor". Consumer Report form postcards were placed in many of the packages before they were conveyed to the lidding machine and into the cold storage rooms of the Millburg Growers Exchange, Millburg, Michigan.

Fig. 2. The "F. M. C. Stericooler" was too large for the doors of the packing house, hence it was placed alongside the building. A roller conveyor brought packed fruit from the packing tables to the machine. In this view as one man placed pad and cover on the baskets, they were rolled into the ice refrigerated truck, shown at the right. The ice crusher and conveyor, shown on the left, carried crushed ice to the machine as needed to maintain the temperature of the solution at 32° F.

water, in which a chlorine-type germicide was added. A pump lifted the treated ice water and distributed it over a perforated metal ceiling.

Packed wooden containers, without pad and cover, were placed on the slow moving conveyor that carried them through the 25-foot machine. The rate of travel through a torrential downpour of treated ice water determined the temperature of the produce when it reached the exhaust end (Fig. 1). As the conveyor slid a row of packages onto a metal apron, the pads and covers were fastened in place and the fruit traveled over roller conveyors to a waiting truck or into the cold storage room (Fig. 2). Crushed ice was conveyed to the machine as needed to maintain 32° F. in the solution.

For the experimental treatment the germicidal chlorine agent[1] was maintained near 130 parts per million by means of frequent titration tests.

[1]"Hypo-Clor".

RAPID PRECOOLING

Lloyd and Newell[1] state that, "Brooks and Cooley found that the rotting of peaches was greatly accelerated by delay in reducing the temperatures. With peaches that were punctured and then dusted with Rhizopus spores, a delay of 24 hours at a temperature of 25° C. (77° F.) before storing at 7.5 ° C. (45.5° F.) gave the rots a lead of 5 days over similar inoculations on peaches, that were delayed but 12 hours before storing at the same temperature."

The precooling device herein described and illustrated, uniformly lowered the temperature of all the peaches. It accomplished in 15 minutes what standard refrigerator cars, most refrigerated trucks and most cold storage rooms accomplish in removing field heat from a volume of warm fruit within 50 to 70 hours.

In order to approach the rate of fruit packing, the conveyor speed was set to carry packages at the rate of about 200 bushels an hour. At this conveyor-gear-ratio, peaches testing 80° F. as they entered the machine left the other end at a temperature of about 45° F. The day (October 2) the experimental samples were packed, the temperature of the air was only 64° F. and the flesh temperature of the fruit was 56° F. Therefore, the 15-minute exposure to the 32° F. solution resulted in a flesh temperature of 38° F. as the peaches left the machine.

METHOD OF TAKING SAMPLE

Because this was a commercial installation in which some 7,000 bushels of Halehaven and Elberta peaches were treated, it was not possible to make a complete test run until October. On the first day of October, a large load of Elberta peaches was brought to the packing house of the Millburg Growers Exchange. The entire load was put through the brush-defuzzer, wherein the fruit was treated with dusting sulfur to which 10 percent of "Zerlate"[2] had been added, as was standard treatment in that packing house. As the packers packed the fruit in bushel baskets, some of the packed bushels were put through the machine, and other bushels were set aside with only the brusher-duster treatment.

[1]Some Factors Influencing the Keeping Quality of Fruit in Transit. J. W. Lloyd and H. M. Newell, Ill. Agr. Exp. Sta. Bull. 350, p. 452, 1930.
[2]DuPont's "Zerlate", a proprietary name for 70 percent zinc dimethyl dithiocarbamate.

The fruit of the two treatments was divided into two lots. Half of the fruit of each treatment was hauled to the College and held at room temperature (75° to 80° F.) for 7 days, then examined for spoilage. Likewise, the remaining bushels of each treatment were placed at 40° F. in the cold storage room of the Millburg Growers Exchange. These baskets were held in cold storage for 7 days, then hauled to the College and placed at room temperature for 4 days, before being examined for spoilage. The object of the holding periods 7 and 11 days, respectively, before determining the result, was to simulate conditions Michigan peaches must encounter, with and without refrigeration, in distant shipments, and the time lapse for distribution to stores and for retail sale.

The peaches represented by Table 1 were grown on one farm. They were harvested October 1, hauled to the packing house of the Millburg Growers Exchange that evening, and were packed the following morning. In Michigan, much of our fruit is not precooled and a considerable amount is transported in unrefrigerated trucks. Although Lot 1 was precooled to 38° F., it traveled to East Lansing in an unrefrigerated truck with the unprecooled fruit of Lot 2. It is reasonable to assume that the temperature of the two lots must have been equalized within some 24 hours after leaving the packing house. It is gratifying to note that the combined treatment called "Stericooling" by the manufacturer, did reduce the spoilage as compared with dusting alone even for so long a time as 7 days without refrigeration.

Very few would be surprised at the results obtained with lots 3 and 4. Rapid precooling and refrigerated storage has seldom failed to reduce the growth and development of peach-rotting organisms. In the case of Lot 3, the peaches were already at or below the temperature of the cold storage room after they came out of the machine.

TABLE 1—*Treated ice water versus brush-dusting of Elberta peaches*

Method of treatment and subsequent handling	Rotted fruits	Sound fruits	Percent rots
Lot 1—Treated with 32° F. ice water plus "Hypo-Clor" germicide, held 7 days at 75 to 80° F. room temperature	466	723	39
Lot 2—Brushed and dusted with dusting sulfur plus 10 percent "Zerlate", 7 days at 75 to 80° F	701	443	61
Lot 3—Treated with 32° F. ice water plus "Hypo-Clor" germicide, held 7 days at 40° F. plus 4 days at 75 to 80° F	183	615	23
Lot 4—Brushed and dusted with sulfur and "Zerlate", held 7 days at 40° F. plus 4 days at 75 to 80° F	344	438	44

Lot 4, on the other hand, was at air temperature (64° F.) and had to lose 16° F. of flesh heat (56° F.) before reaching the temperature of the storage room. As this experiment was a test of two commercial packing-house treatments against spoilage, it gives no direct answer of the portion of rot reduction that might be credited to ultra-rapid precooling and what could be credited to the "Hypo-Clor" incorporated with the refrigerant. There is, however, some indication of the probable benefit exerted by the germicidal agent. After the fruit of Lot 1 reached the temperature of the fruit of Lot 2, both lots were held at 75° to 80° F. for 7 days prior to making the counts shown in Table 1. The 22-percent better control in Lot 1 appears to the credit of "Hypo-Clor" over that of the sulfur-"Zerlate" dust treatment.

PEACH-ROT IN RELATION TO POINT OF ENTRANCE

While examining each of the 3,910 peaches, it was thought worth while to record each spoiled peach in terms of the place of entrance of organisms. These data are recorded as Table 2, lots 1 and 2, and Table 3, lots 3 and 4.

It is obvious that there were two vulnerable means of entrance for the rot causing organisms: the stem end and where an infected

TABLE 2—*Elberta peaches held at 75 to 80° F. for seven days*

Source of rot	Lot 1		Lot 2	
	Precooled plus "Hypo-Clor"		Brushed-dusted, not precooled	
	Number	Percent	Number	Percent
Sound fruit	720	60.7	443	38.7
Stem end	236	19.9	386	33.7
Insect injury	000	00.0	1	.1
Skin rupture	18	1.5	7	.6
Contact with rot	194	16.4	291	25.4
Bruise	18	1.5	16	1.4

TABLE 3—*Elberta peaches stored seven days at 40° F. plus four days at 75 to 80° F.*

Source of rot	Lot 3		Lot 4	
	Precooled plus "Hypo-Clor"		Brushed-dusted, not precooled	
	Number	Percent	Number	Percent
Sound fruit	615	77.1	438	56.0
Stem end	124	15.5	239	30.6
Insect injury	000	00.0	000	00.0
Skin rupture	9	1.1	14	1.8
Contact with rot	45	5.6	72	9.2
Bruise	5	.6	19	2.4

peach came in contact with other specimens. Refrigeration at 40° F. did not greatly reduce the infection at the stem end of the fruit. The combined hydrocooling and prophylactic action of the "Hypo-Clor" compound considerably reduced the percentage of infected fruit as compared with dusting the fruit as it passed through the defuzzing unit.

Holding the fruit at 40° F. did reduce the percentage of infection classified as resulting from contact with rotted fruit as indicated in Table 3.

No attempt was made to determine what organisms were responsible for the decay. It was assumed that the brown-rot fungus[1] was the dominant organism, but that blue mold and black mold also took their toll. Brooks and Fisher,[2] reporting some 29 years ago on "Transportation Rots of Stone Fruits as Influenced by Orchard Spraying," had these pertinent conclusions to make. They state: "With all the rots temperature has been an extremely important factor . . . *Rhizopus* (black-mold rot) was entirely eliminated at the lower temperature (41° F.) and *Penicillium* (blue-mold rot) and *Monilia* (brown-rot) were greatly reduced."

DISCUSSION

The severity of the brown-rot fungus as exhibited in many Michigan peach plantings in 1947, makes it difficult to imagine a more severe test for any treatment.

Devices for hydrocooling perishable comestible products in preparation for a long haul from Pacific Coast areas have been in use for several years. The summer of 1947 was the first time that a machine devised for hydrocooling and treating certain produce was brought to Michigan for a commercial test. The machine called the "F. M. C. Stericooler" is a product of the Food Machinery Corporation. One of these units was installed by the John Bean Division of Food Machinery Corporation at the packing house of the Millburg Growers Exchange, to be tested against peach-spoiling organisms of harvested fruit.

The tests herein reported were conducted in order to assist in obtaining a preliminary measure of the effectiveness of the treated ice water on Elberta peaches, when given a 15-minute exposure. The results shown in Table 1 indicate a marked reduction in rot control

[1] *Monilinia fructicola (Sclerotinia fructigena).*

[2] Brooks, Charles and Fisher, D. F. Transportation Rots of Stone Fruits as Influenced by Orchard Spraying. Reprint G-257, Jour. of Agr. Res., Vol. XXII, No. 9, p. 477. November 26, 1921.

in favor of the "Stericooler" treatment, as compared with the more common packing house method of dusting the fruit with a common fungicide. The percentage of rot may appear high as compared with that in other seasons, but it should be remembered that brown-rot disease was unusually severe at blossom time and was not brought under control in infected orchards regardless of the spraying program. The orchard from whence the test fruit came was given its last spraying the day before picking started, but some brown-rot infected fruit was removed by the sorters after the fruit reached the packing house. Under such conditions, it is logical to assume that some infected fruit went into these packages that showed no external evidence of being infected. If this assumption is accepted, it may account for the relatively high percentage of rotted fruit regardless of precooling, germicidal treatments or subsequent cold storage temperature.

The location of entrance of rot, shown in tables 2 and 3, indicates two vulnerable sources of entrance by the organisms. The rupture of skin, where the fruit separates from the branch, is the point of highest infection. Second only to the "stem end" is the point of contact between an infected fruit and adjoining fruit.

In each case, with or without subsequent refrigeration, the treatment in the "Stericooler," wherein all the peaches were quickly reduced to 38° F. by the germicidal ice water, greatly reduced the amount of infection. Prior to these tests, no fungicide or combination of fungicides has proven to be superior to certain grades of dusting sulfur, as a packing house treatment for peach-rot organisms. Hydrocooling, with "Hypo-Clor" as a germicidal supplement, greatly reduced the amount of decay as contrasted with commercially packed peaches treated with dusting sulfur in which 10 percent of "Zerlate" was incorporated.

SUMMARY

Commercially packed Elberta peaches in wooden bushel baskets were treated in an "F. M. C. Stericooler" with 32° F. ice water in which a chlorine-type germicide—"Hypo-Clor"—was held at 130 parts per million. Similar lots were treated with dusting sulfur, in which was incorporated 10 percent of "Zerlate," a standard treatment in the packing house of the Millburg Growers Exchange. The treatment afforded by the "F. M. C. Stericooler" showed superior control of peach-rotting organisms over the packing house dusting treatment.

Peaches held in cold storage, following the two treatments, showed less spoilage than lots not refrigerated after treatment.

A SIMPLE DEVICE FOR APPLYING GROUND SPRAYS

By C. L. HAMNER and LOREN D. TUKEY
SECTION OF HORTICULTURE

THE INCREASED USE of chemicals in weed control has emphasized the need for versatile spray equipment. When 2,4-D is used at the rate of 1 to 1½ pounds per acre it has usually been applied in 150 to 200 gallons of water, the water merely serving as the carrier for the toxicant. Because of the inconvenience in using such large volumes of water, the present trend has been towards concentrated solutions, that is, applying the same amount of chemical per acre, but reducing the amount of water. The successful application of 2,4-D in as low as 5 to 10 gallons per acre has been reported.

The increased use of 2,4-D as a selective herbicide on lawns, golf courses, parkways, pastures, corn fields, and so on, has greatly increased the need for a sprayer of low cost that can apply concentrated solutions. To meet this need an inexpensive, easily-operated sprayer has been constructed at Michigan State College from a common 3-gallon hand sprayer (Fig. 1), mounted on a hand garden cultivator and equipped with a spray boom. Necessary alterations are small and inexpensive. The equipment needed is as follows:

1. Cultivator
2. 3-gallon hand sprayer
3. Gasoline filter
4. Boom
    a. 6—⅛-inch x 12-inch nipples
    b. 7—⅛-inch x 6-inch nipples
       5—⅛-inch x 1-inch nipples
    c. 9—⅛-inch elbows
    d. 4—¼-inch to ⅛-inch reducing elbows
    e. 5—⅛-inch tees

ARTICLE 30-61

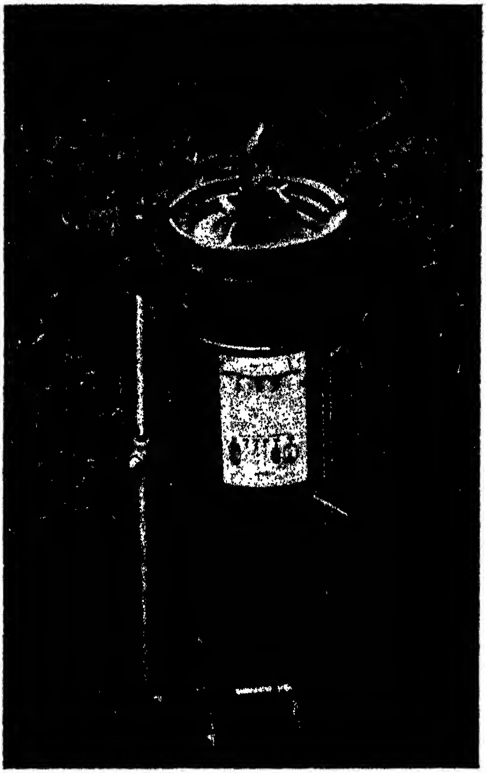


Fig. 1. Sprayer with pipe attachment to boom; gasoline filter can be used where concentrate sprays are used with small opening spray nozzles.

f. 2—1/8-inch plugs
g. 1—1/4-inch coupling
h. 1—1/4-inch to 1/8-inch reducer sleeve
i. 18 inches of heavy, small-diameter rubber hose
j. 4—1/4-inch nozzles

5. 12 inches of angle iron
6. 5 feet of strap iron
7. 8—1/4-inch by 1½-inch bolts
8. 8—1/4-inch nuts and washers
9. A little wire

Any garden cultivator will do, but it has been found that a metal cultivator similar to that shown in Fig. 2 is especially adaptable. The spray tank is mounted as shown in Fig. 3. Necessary alterations are as follows: Invert the two horizontal metal bars which are connected to the wheel at one end and to which the cultivating equipment is commonly attached. Spread the bars so that they will provide a broad base for the tank to rest upon. The two metal bars which extend downward from the handles are moved forward at the bottom as shown in Fig. 2. It will be necessary to shorten the bars and bore a hole in each. The two short pieces of metal bar can be used for the construction of suitable rear legs. A short piece of angle iron is bent in the form of a horseshoe to hold the bottom of the tank in place. It may be bolted or welded to the cultivator (Figs. 2 and 3). The upper part of the spray tank is supported by a "U" of strap iron at the back and by a straight piece of strap iron in front. When they are bolted together they hold the tank snugly (Figs. 2 and 3).

Fig. 2. Cultivator with braces for spray tank to rest upon.

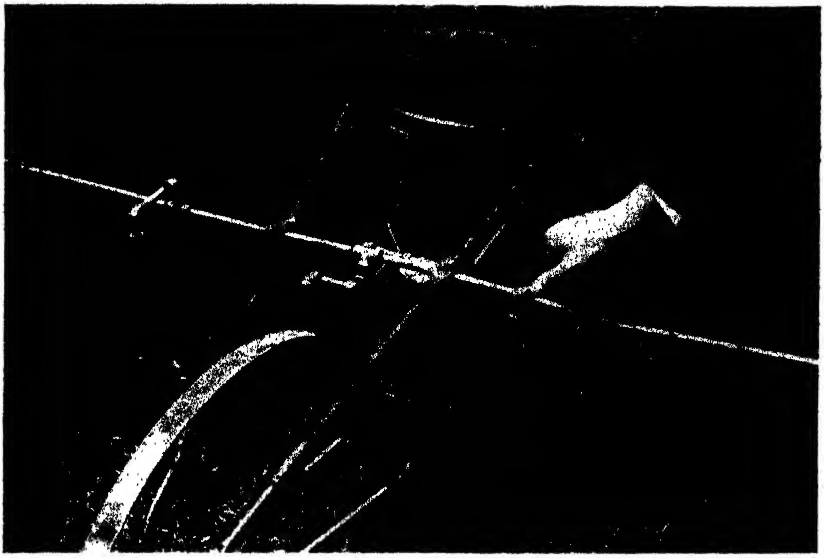


Fig. 3. Close-up of spray boom showing adjustable spray arm; this permits a flexible control of spray on row crops.

The shut-off valve is located near the left handle for convenience in operation. A gasoline filter is used to remove all large size particles that might clog the nozzles. A ⅛-inch pipe and fittings connect the tank with the filter (Fig. 1). A short piece of heavy, small-diameter rubber tubing is used to connect the filter to the boom so as to facilitate adjustment of the boom at the desired height from the ground. The boom may be clamped to the cultivator in any convenient location (Fig. 4).

The boom is constructed of ⅛-inch pipe and fittings. Nozzles may be placed 12 or 24 inches apart (Figs. 3 and 4). Fan-type nozzles obtained from the Monarch Manufacturing Company, Philadelphia, are satisfactory. The sprayer will cover a swath 8 feet wide. By merely changing the size of the opening of the spray nozzle, delivery rates may be controlled. With a small delivery rate and by walking rapidly, it is possible to cover several acres in a day, using as low as 3 gallons of concentrated spray material per acre.

A sprayer of such simple construction can be easily adapted to a specific crop such as corn and gladioli where 2,4-D is to be applied between the rows and away from the crop.

In addition to its use for applying 2,4-D, this type sprayer can readily be used for applications of other materials in concentrated form such as insecticides, fungicides and hormones. It is believed that this new adaptation of a hand sprayer may have large-scale use where concentrated sprays are used. It should also prove definitely superior to the conventional hand sprayer in the application of dilute sprays.

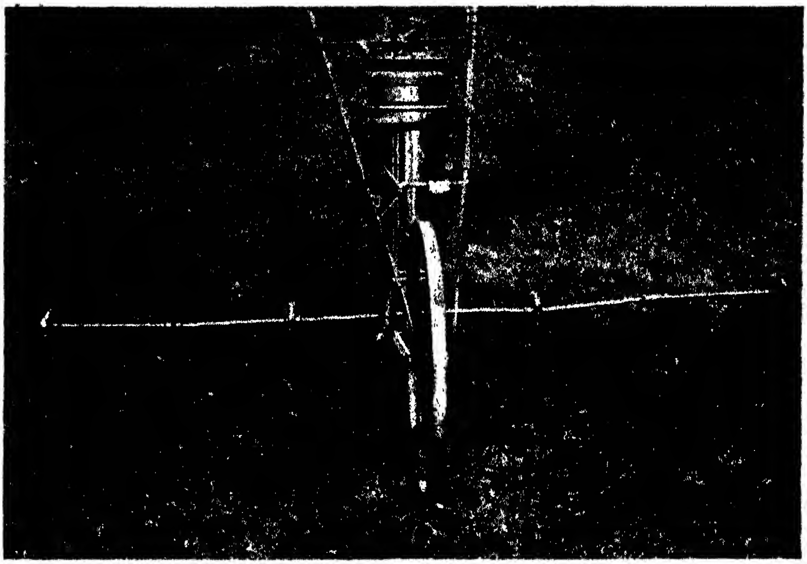


Fig. 4. Sprayer assembled with boom raised for spraying 2,4-D on lawns, golf courses, and the like.

EXPERIMENTAL FEEDING OF SULFATHIAZOLE SYRUP TO COLONIES OF BEES INFECTED WITH THE AMERICAN FOULBROOD DISEASE

By R. H. KELTY
SECTION OF HORTICULTURE

THE DISEASE known as American foulbrood is the cause of severe losses to beekeepers. The causal organism *(Bacillus larvae)* is a spore-former, capable of living for years in honey and combs in infected hives. It is carried in honey and on combs and hive equipment. Strong colonies "rob" honey from weaker diseased colonies and become infected with the disease. The beekeeper may spread the disease without realizing it by interchanging combs and hive parts from infected colonies to clean colonies. The disease is infectious, contagious and progressive. Ordinarily, infected colonies do not remove the diseased material from their combs and steadily become weaker and die during the winter following time of infection. Certain colonies of bees, apparently because of greater activity in "house cleaning," remove the diseased material and hold the disease in check for a time. But the disease is so difficult to control that experienced beekeepers usually kill the bees and sterilize the equipment in diseased colonies.

Since 1881, Michigan has had laws providing for inspection of apiaries, and since 1937 has prohibited the importation of bees on combs because of the danger of spreading foulbrood. The Apiary Inspection Bureau of the State Department of Agriculture has been required by law to burn diseased colonies when found, and by statewide apiary inspection has reduced the amount of foulbrood from a high point of from 40 to 60 percent diseased colonies in certain counties in the beginning to the present low point of 2.6 percent diseased colonies for the entire state in 1947.

The requirement that the Apiary Inspector burn colonies infected with the foulbrood disease when found has been very costly to many

ARTICLE 30-62

beekeepers, although the law enables the beekeeper to sterilize his equipment if he did the job before the bee inspector arrived.

Since 1941, the Bee Culture Laboratory of the U. S. Department of Agriculture has made studies of the effect of the so-called sulfa drugs and other materials, such as penicillin, upon the causal organism of American foulbrood *(Bacillus larvae)* in the laboratory but obtained no evident cure. On the other hand, the Missouri Agricultural Experiment Station and some other agencies have studied the effects of these drugs under apiary conditions and have obtained apparent temporary cures. Many beekeepers and some research workers have claimed that sulfathiazole did effect a cure for American foulbrood and that it was no longer necessary to burn colonies infected with American foulbrood.

July 11, 1945, the Michigan State Department of Agriculture requested the Michigan Agricultural Experiment Station to undertake experiments to determine what benefit sulfonamides may have in curing or controlling American foulbrood. It was decided to perform feeding tests under commercial apiary conditions.

PROCEDURE

Each colony in the experiment was provided with a division-board type feeder which remained in the colony throughout the experiment. The Missouri Agricultural Experiment Station reported apparent cure with a dosage of ½ gram sulfathiazole per gallon of sugar syrup and this dosage was used throughout the experiment. After the first feedings, it was found that sulfathiazole tablets were insoluble, much of the material settling out of the medicated syrup. Sulfathiazole sodium, which is soluble, was used during the remainder of the experiment.

The sugar syrup was made of three parts sugar to two parts of boiling water to which was added ½ gram sulfathiazole sodium for each gallon of syrup. The syrup was heated and stirred until complete solution was obtained as indicated by the clarity of the liquid.

In late July 1945, 21 colonies affected with American foulbrood were assembled at East Lansing for the experimental feeding. Sixteen of the 21 colonies were extra strong and lightly infected with the disease. The remaining five colonies were weaker and the disease was farther advanced. Each colony was fed approximately 3 quarts of the sulfathiazole syrup at 1-week intervals. The bees were gathering very little nectar and took the syrup readily.

After four feedings, visible evidence of American foulbrood had disappeared in nine of the strong colonies. A few scattered cells of disease remained in seven of the strong colonies. Four of the five badly diseased colonies showed marked improvement in cleaning out diseased material, while one colony showed little improvement.

After eight successive feedings, visible evidence of foulbrood had disappeared in the 16 strong colonies. They were considered strong enough to winter, and were given an additional 2 gallons of sulfathiazole syrup for winter food. Since the remaining five colonies were not considered strong enough to winter and had not removed all diseased cells, they were killed and the equipment was sterilized.

The 16 sulfathiazole-fed colonies lived over winter, and during the spring months of 1946, they were given five successive 3-quart feedings of sulfathiazole syrup at 1-week intervals from April 1 to May 6. No visible evidence of American foulbrood was observed in these colonies.

July 12, 1946, 35 lightly infected strong colonies were added to the experimental apiary. These colonies averaged approximately 40 pounds of honey per colony before being fed sulfathiazole syrup. The entire experimental apiary of 51 colonies was fed six successive 3-quart feedings of sulfathiazole syrup at 2-week intervals between July 12 and October 1, 1946. After three successive feedings, all of the 35 lightly infected strong colonies had removed all visible evidence of foulbrood, and the entire 51 experimental colonies seemed free from disease. Very little surplus honey was produced in the experimental apiary in 1946.

By October 14, all experimental colonies were considered strong enough for winter. Surplus honey from stronger colonies was given to other colonies needing winter food, and all colonies were given a last feeding of 3 quarts of sulfathiazole syrup.

During the winter of 1946-47, six experimental colonies died leaving approximately 30 pounds of food per colony. Twenty-five 3-pound package colonies were installed on May 6 on equipment from the experimental apiary, and the food from the six dead colonies was divided among the 25 package colonies. The package colonies were also fed three 3-quart feedings of sulfathiazole syrup at 3-day intervals for reserve food supply. Two package colonies became queenless and were united with queen-right experimental colonies. Five other queen-right package colonies were united with wintered-over

experimental colonies having failing queens, leaving a total of 63 colonies in the experimental apiary May 27, 1947.

The entire experimental apiary was fed four successive 3-quart feedings of sulfathiazole syrup from May 15 to June 26, 1947. No visible evidence of American foulbrood was seen in any of the experimental colonies during that period. All colonies were very strong with much brood. By July 1 no surplus honey had been gathered by the experimental colonies and prospects in the neighborhood were negative.

Since all colonies were very strong with no nectar in prospect locally, and since all colonies had been apparently free from disease all of the spring period, it was decided to move the 63 experimental colonies to two established apiaries in Tuscola County where considerable acreage of sweet clover promised a nectar flow. On July 7, 1947, the experimental colonies were moved from East Lansing to Tuscola County, 43 colonies being placed in an established apiary on Section 30-W, Elmwood Township and 20 colonies being placed in an established apiary on Section 27-S, Columbia Township. Both of these apiaries had been free from foulbrood on previous inspections.

No sulfathiazole syrup had been given to any of the experimental colonies since June 26, 1947, and it was desired to observe the effect of a nectar flow upon the experimental colonies.

On August 11, 1947, representatives of the State Apiary Inspection Service of the State Department of Agriculture, found 28 of the 43 experimental colonies lightly infected in the apiary on Section 30-W, Elmwood Township, and burned the colonies and sterlized the equipment. On August 13, 1947, the Apiary Inspectors found 13 of the 20 experimental colonies in the apiary on Section 27-S, Columbia Township, lightly infected and burned the colonies and sterilized the equipment.

It is likely that in the period June 26 to August 11-13 when no sulfathiazole syrup was fed to the experimental colonies during much of which period no nectar was being gathered by the bees, bees in the larval stage may have been fed diseased honey held in reserve in the hive during the experiment, which diseased honey fed in the absence of sulfathiazole syrup, caused a reappearance of foulbrood in the hives.

To date, no visible evidence of foulbrood has appeared in the remaining 22 experimental colonies, all of which were package bee colonies receiving 3 extra feedings of sulfathiazole syrup at installation time.

SUMMARY

Year	Number of experimental colonies	Number of 3-quart feedings of sulfathiazole syrup	Number of colonies apparently cured	Number of colonies destroyed in which disease reappeared
1945........	21.................................	8	16	5
1946........	51.................................	6–11	51	0
1947........	63—package colonies..................... wintered colonies.....................	7 4	22 —	41 —

CONCLUSIONS

From this experiment it appears that the feeding of sulfathiazole syrup to strong colonies affected with American foulbrood may enable the colonies to remove visible evidence of the disease, provided the colonies are fed the sulfathiazole syrup continuously while bees are in the brood stage. It seems that the evidence of the disease may reappear if the feeding of the sulfathiazole syrup is discontinued, particularly if there is a reserve supply of diseased food in the hive.

JOURNAL ARTICLE ABSTRACTS

A Method for the Estimation of the Advancement of Vegetation by the Use of Daily Maximum Temperatures

PARTRIDGE, N. L.

Proc. Amer. Soc. Hort. Sci. 49: 7-14. 1947 [*Journal Article 714 (n. s.) from the Michigan Agricultural Experiment Station*]

Data comprising date of first bloom for peaches and daily maximum temperatures covering 24 seasons were used. Accumulations above various maximum temperatures ranging from 28° to 50° F. for periods beginning January 1, February 1, March 1 and April 1, respectively, and extending to the date of the first bloom of the peach, were calculated. The use of the coefficient of variability was an unsatisfactory measure of the approximation of the various indices to vegetation as indicated by peach bloom. A suitable means for evaluating the indices was determined, and it was concluded that the accumulation could be commenced January 1, February 1 or March 1 without changing significantly the value of the resulting index. There was also a wide range of maximum temperatures of approximately equal value for bases. The use of an index calculated from a maximum temperature base of 40° F. commencing January 1 was suggested for Michigan conditions. Tables calculated on this basis for 26 seasons are given to illustrate the variation between seasons, the assumption being that the progress of vegetation will be rather closely correlated with these indices.

Effect of Various Mulching Materials on Orchard Soils

TURK, L. M. AND PARTRIDGE, N. L.

Soil Science. 64 (2): 111-125. 1947 [*Journal Article 866 (n. s.) from the Michigan Agricultural Experiment Station*]

In the fall of 1939, an experiment, involving the use of lysimeters, was started for the purpose of studying the effect of different kinds of mulching materials on the accumulation of soil nitrates and the conservation of soil moisture. The surface soil (7 inches) of three soil types (Coloma sand, Hillsdale sandy loam, and Miami silt loam) was used, and mulches of alfalfa hay, straw, and straw plus ammonium sulfate were applied to each of the three soils; other lysimeters received no mulch. Additional mulches of peat, shredded corn stover, shredded corn stover plus ammonium sulfate, sawdust, shavings, and gravel were used on the Hillsdale sandy loam. Each treatment was made in triplicate and determinations were made of the quantity of water which percolated through the soils, the amount of nitrates produced, and the changes in exchangeable cations in the soils. With the exception of peat all mulches were effective in decreasing evaporation losses of water. The peat mulch had such a high absorptive capacity for water that with light rains or long intervals between rains very little water reached the soil. The quantity of nitrates produced in the unmulched soils was greater than in the mulched soils except where alfalfa was used in those soils which had received straw mulch plus ammonium sulfate. The decrease in

nitrate production under straw mulch and similar types of mulching materials is believed due to poorer aeration brought about primarily by a higher soil moisture content and to a somewhat lower temperature. In general, the least depressive effect on nitrate production occurred in the better aerated soil. Mulches such as alfalfa, straw, and corn stover contribute materially to the plant nutrient content of the soil.

Listerellosis in Sheep of Michigan

GRAY, M. L., THORP, F., JR., NELSON, R. H., AND SHOLL, L. B.

M.S.C. Veterinarian. 7: 161-163. 1947 [Journal Article 879 (n. s.) from the Michigan Agricultural Experiment Station]

Four cases of Listerellosis in sheep have been confirmed by isolation and identification of *Listerella monocytogenes*. Three cases, two ewes and a lamb, occurred in the same flock and the fourth case in a nearby flock. The infection in the ewes was manifested by a central nervous system disorder, while the lamb displayed a typical septicemia. The cultures when injected intracerebrally into rabbits produced death in from 20 hours to 4 days. In all instances listerellae were isolated from the brain and liver. When instilled into the eyes of rabbits it produced a marked keratitis and conjunctivitis within 36 hours which persisted for 4 days.

Rumen Digestion Studies. I. A Method of Investigating Chemical Changes in the Rumen

HALE, E. B., DUNCAN, C. W., AND HUFFMAN, C. F.

Jour. Nutrition. 34 (6): 733-746. 1947 [Journal Article 886 (n. s.) from the Michigan Agricultural Experiment Station]

A critical appraisal of the lignin ratio method was made to obtain information on the rate of digestibility of various components in roughage. A theoretical and experimental basis for the calculation of the rumen digestion coefficients is presented. By the use of the suggested formulae, measurements can be made either of maximum digestion or the rate of rumen digestion. Lignin values form the basis of both of these procedures but are applied in two distinct ways. These methods are not suitable for determining digestion coefficients of mixed rations since concentrates are not only low in lignin but they also pass from the rumen more rapidly than roughages. The principles forming the basis for the rumen digestion calculations received special attention.

Rumen Digestion Studies. II. Studies in the Chemistry of Rumen Digestion

HALE, E. B., DUNCAN, C. W., AND HUFFMAN, C. F.

Journal of Nutrition. 34 (6): 747-758. 1947 [Journal Article 887 (n. s.) from the Michigan Agricultural Experiment Station]

Studies of the chemical changes in the bovine rumen show that during the first 6 hours after feeding there was rapid digestion of proteins and carbohydrates. The predominate phenomenon during the second 6 hours was a rapid disintegration of cellulose. The digestion of proteins and carbohydrates paralleled the digestion of cellulose. Rumen digestion came to a standstill within 12 hours after

feeding and prolonged digestion periods up to 24 hours did not increase rumen digestion coefficients. Average rumen digestion coefficients for 8 trials at 12-14 hours after feeding were: dry matter 48.4, protein 59.6, nitrogen-free extract 65.2, crude fiber 27.2, cellulose 43.4, other carbohydrates 83.0 and lignin 3.1 percent. After plant fragments pass from the rumen variable amounts of lignin may be digested, thereby exposing varying amounts of cellulose and protein to further digestion. The caecum plays only a supplementary role in the disintegration of roughage in the ruminant. An average of 11.6 percent of the cellulose and 9.5 percent of the protein was found to be digested in the caecum. The production of fatty acids in the rumen was demonstrated. Maximum increases, after the increase due to digestion was eliminated, were 54.9 percent on an alfalfa hay ration and 281.7 percent on a beet pulp ration. The rapid dissipation of fatty acids from the rumen, together with the marked synthesis, suggests that fatty acids make a highly significant contribution to the nutrition of the ruminant.

The Immunization of Guinea Pigs with Mucoid Phases of Brucella

HUDDLESON, I. F.

Am. Jour. Vet. Res. 8: 377-380. 1947 [Journal Article 888 (n. s.) from the Michigan Agricultural Experiment Station]

When live cell suspensions of certain mucoid growth phases of *Brucella suis* and *Brucella melitensis* were prepared in a suitable concentration and injected into normal guinea pigs, they were capable of engendering a high degree of active immunity against experimental infection with all three species of Brucella.

Cell suspensions of *Br. suis*, M. phase 2, after irradiation with ultraviolet light to a sufficient degree to render all but a few cells in a 1-mg. dose nonviable, were also capable of producing a high degree of immunity in guinea pigs against experimental infection with *Br. suis* and *Br. melitensis*.

The vaccine-treated guinea pigs that were found free from infection after exposure did not show specific agglutinins in the blood serum in dilutions of 1:25 or above.

The results of the experiments reported herein suggest the possibility of obtaining a high degree of immunity with this type of Brucella vaccine against brucellosis in animals and human beings.

Cannibalism and Feather Picking in Chicks as Influenced by Certain Changes in a Specific Ration

SCHAIBLE, P. J., DAVIDSON, J. A., AND BANDEMER, S. L.

Poultry Science. 26 (6): 651-656. 1947 [Journal Article 890 (n. s.) from the Michigan Agricultural Experiment Station]

The vicious habit of picking feathers, comb, wings, toes, tails, vent, and other parts of the body of the chicken is one of the serious problems of keeping poultry in confinement. Environmental factors as well as nutrition involving various management procedures have been cited as the causes of this habit.

A basal ration containing a high percentage of yellow corn and a low content of protein, phosphorus and fiber produced a high incidence of cannibalism and feather picking in chicks started in a chick-starting battery. Various ingredients were added to the basal ration and the difference in cannibalism and

feather picking noted. These ingredients included inorganic supplements, including different calcium compounds and sodium compounds, several sources of fiber, and various protein supplements.

Certain of the protein supplements seemed to be more effective than others, with casein being the principal ingredient which at various levels reduced the amount of picking and cannibalism. At a 2-percent level, casein reduced cannibalism and improved feathering while 3.6 percent was required to reduce feather picking.

The time of year is not an important factor. The results of these experiments indicate that malnutrition may of itself result in feather picking and cannibalism in White Leghorn chicks.

The Amino Acid Composition of Bovine Semen

RAY SARKER, B. C., LUECKE, R. W., AND DUNCAN, C. W.

Jour. Biol. Chem. 171 (2): 463-467. 1947 [Journal Article 893 (n. s.) from the Michigan Agricultural Experiment Station]

An amino acid analysis of a composite of 149 semen samples obtained from 40 different bulls is reported. These bulls were used routinely for artificial insemination and were of the Holstein, Guernsey, and Jersey breeds. The semen was centrifuged at 5,000 r.p.m. and the sperm separated from the seminal plasma. The sperm and seminal plasma were frozen and dried in this state by sublimination. The concentration of 11 amino acids in the sperm and seminal plasma is reported. With the exception of arginine, leucine, and tryptophan, the amino acid composition of sperm and seminal plasma is quite similar. The arginine content of sperm is very high but is relatively much lower in seminal plasma. The tryptophan concentration in seminal plasma is considerably higher than that found in sperm.

Heavy Minerals in Some Podzol Soil Profiles in Michigan

MATELSKI, R. P. AND TURK, L. M.

Soil Science. 46: 469-487. 1947 [Journal Article 898 (n. s.) from the Michigan Agricultural Experiment Station]

A study was made of heavy minerals in some of the northern Michigan podzol profiles in order to aid in explaining certain morphological peculiarities in these soils. It was thought that such a study would aid in revealing geological differences in the soil horizons and in determining the intensity of the weathering processes in various horizons. Two groups of podzol soils were investigated; namely, Emmet, Kalkaska, and Wallace sands, designated as group I; and Grayling, Rubicon, Roselawn, and Eastport sands, designated as group II. Members of group I were characterized by a stronger expression of the Morphological features of typical podzol profiles than were members of group II. Heavy mineral separations were made on the fine sands and there were significantly greater amounts of heavy minerals in all horizons of the group I soils than in the corresponding horizons of the group II soils. In all the soils, the total amount of heavy minerals was greatest in the C Horizon. In most of the soils, the B Horizon had the lowest content of heavy minerals. The brown B Horizon of these podzols is the result of a vigorous decomposition of a relatively high original content of opaque and ferromagnesian minerals. Organic matter is an effective weathering

agent of some heavy minerals in the B Horizons. The least resistant mineral to podzol weathering was found to be dark green hornblende, followed by grey-green hornblende, the opaque minerals, and the garnets. In general, the B Horizons suffered a greater decomposition of the heavy minerals than did the A or C Horizons. Kalkaska and Emmet sands (soils that support a hardwood cover) contained a greater quantity of calcium and magnesium heavy minerals in all horizons of the profile than did Wallace, Rubicon, Roselawn and Grayling sands (soils that support a pine cover). The data suggest that the intense brown B Horizon in group I soils is due to a greater amount of iron oxide, organic matter and perhaps to a greater orginal content of the opaque and ferromagnesian minerals (and of the greater decomposition of these minerals) than in the group II soils.

The Detection and Correction of Bacterial Contamination of Milk Bottles in a Bottle Washer

BRYAN, C. S., BORTREE, A. L., AND LUCAS, P. S.

Jour. Milk Food Tech. 10 (6): 319-322. 1947 [Journal Article 899 (n. s.) from the Michigan Agricultural Experiment Station]

An instance of bottle washer contamination of milk bottles from a crate washer is described. Physically-clean milk bottles yielded bacteria counts up to 94,000 per quart bottle when this should be no more than 1,000 and usually 200 or less. Chlorination, as the final treatment in the bottle washer, yielded satisfactory bottles, although the contamination continued at the inside rinses. The installation of a vacuum breaker on the water line between the bottle washer and the crate washer corrected the combination problem. The data presented emphasize the importance of proper installation of case and bottle washers.

Blood Studies in Dogs Following the Injection of Penicillin

BRINKER, W. O.

North American Veterinarian. 25: 31-33. 1947 [Journal Article 909 (n. s.) from the Michigan Agricultural Experiment Station]

Penicillin was administered in various vehicles, dosages, and routes of injection to determine (1) the blood plasma levels of penicillin at different intervals following its administration, and (2) the effect on the peripheral blood. Seventy-one trials were completed, using 12 normal, healthy dogs.

Following a single injection of 1,000 units per pound of body weight in a vehicle consisting of 5-percent dextrose in physiological saline, the penicillin blood plasma concentration was found to be approximately the same for all four routes of injection at 30 minutes; however, the penicillin level of 0.03 unit or better was maintained approximately twice as long when the subcutaneous, intramuscular, and intraperitoneal routes were used as compared to the intravenous route.

Penicillin blood plasma levels following the administration of various doses (250, 500 and 1,000 units per pound of body weight) in 5-percent dextrose and physiological saline given intramuscularly and subcutaneously were studied. In this series of trials the resulting levels following subcutaneous administration were found to be slightly superior to those following intramuscular administration both in concentration and prolongation of plasma level.

When administered subcutaneously, 5-percent dextrose in physiological saline was found to be equal or slightly superior to the water-in-oil in maintaining penicillin plasma levels. Romansky's Formula was found to excell the above vehicles, as a level of 0.03 unit or better was maintained in all cases at least 6.5 hours following a subcutaneous injection of 1,000 units per pound.

In each trial the first and last blood sample drawn was checked for erythrocyte and leukocyte cell counts, hemoglobin content, and leukocyte differential count. These data indicate that single injections of penicillin in various dosages have no immediate effect on altering the peripheral blood in the normal healthy dog.

The subcutaneous route of injection was found to be the one choice for ease of administration, least objection on the part of the dogs, and for production and prolongation of the penicillin blood plasma level. No local or systemic reactions were noted following the injection of the various penicillin preparations used in this experiment. On autopsy of the dogs at the termination of the study no macroscopic lesions were found at the sites of injections.

Shrinkage of Spun Rayons in Hand and Machine Laundering

TEAR, J. F.

Rayon Textile Monthly. 28 (9): 83-86. 1947 [Journal Article 910 (n. s.) from the Michigan Agricultural Experiment Station]

In recent years, rayon, and particularly spun rayon, fabrics have replaced cottons for women's wash dresses, for sport wear and children's clothing. One difficulty with rayons and especially spun rayons has been dimensional change, the shrinking and stretching of fabrics. The purpose of this study was to determine the amount of dimensional change in a selected group of spun rayons when laundered by hand and by machine. The 37 spun rayons tested were purchased in Michigan in the spring of 1944.

The fabrics that were hand laundered retained their original texture and appearance better than those laundered by machine. The latter looked as though they had been washed and ravelled very badly.

There was no appreciable difference in the amount of shrinkage that occurred in the hand laundered and the machine laundered, most of them shrinking 5 percent or more. This amount of shrinkage is so high that any garments made from these fabrics would in all probability be unsatisfactory after laundering.

A Chemical Control of Seedstalk Development in Celery

WITTWER, S. H., COULTER, L. L., AND CAROLUS, R. L.

Science. 106 (2763): 590. 1947 [Journal Article 913 (n. s.) from the Michigan Agricultural Experiment Station]

Premature seeding of celery (variety, Cornell 19) was prevented by spraying the young seedlings, prior to cold exposure and field transplanting, with 100 parts per million of alpha-ortho-chlorophenoxypropionic acid. All plants sprayed with the chemical, whether subsequently exposed to cold or not, remained vegetative throughout the growing season. Similarly handled but unsprayed seedlings produced seedstalks.

Evaluation of Some Poultry Remedies

STAFSETH, H. J.

M.S.C. Veterinarian. 8 (11): 56-64, 86. 1948 [*Journal Article 931 (n. s.) from the Michigan Agricultural Experiment Station*]

This work was done at the request of the Food and Drug Administration, Washington, D. C. The purpose was to determine whether certain claims made concerning these "remedies" were true. Millions of dollars are spent by poultrymen throughout the country for worthless remedies, some of which are actually harmful when used under given conditions. The "remedies" concerned were tested under controlled condition *in vivo* and *in vitro* with the following results:

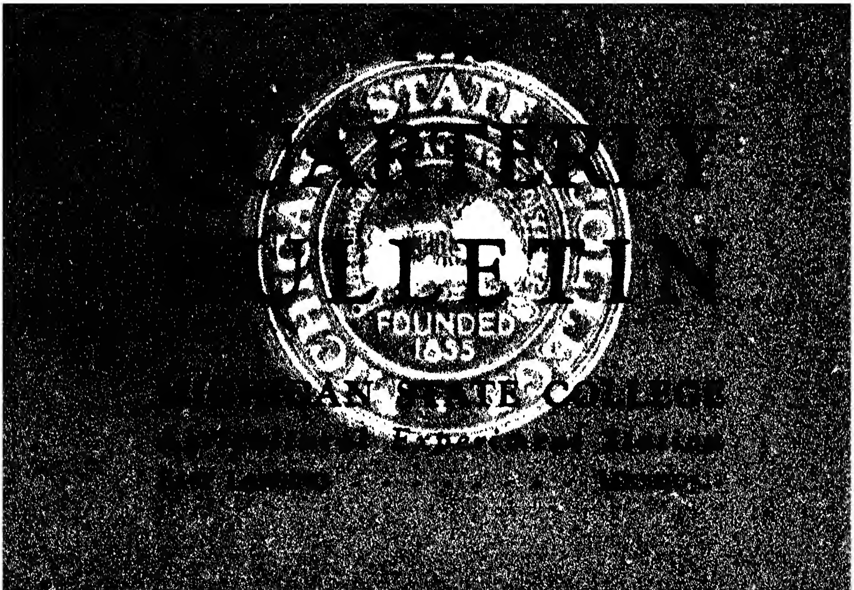
None of the experiments here reported revealed any evidence justifying the use of any of the remedies tested. They proved to be perfectly worthless; in fact, GM appears to be harmful when given to chickens and chicks affected with pullorum disease.

Medication with the "remedies" employed in these experiments did not materially affect appetite, water consumption or body weight.

So-called intestinal astringents were tested for astringency, coagulation of protein. No results were obtained that would justify their use as "intestinal astringents".

The products recommended as antiseptics to be used in drinking water, when subjected to phenol coefficient and agar cup tests, proved to be entirely worthless.

If potassium dichromate has any value in the medication of poultry, as is thought to be the case in the treatment of pullet disease, (Weisner, 1940, and Jungherr and Matterson, 1944) there is certainly no evidence supporting any claims of astringent or antiseptic action in the recommended dosage. This is also true for the other products recommended for use in drinking water and tested in the course of these experiments.



VOLUME 31 · AUGUST 1948 · NUMBER

CONTENTS

(Continued on Next Page)

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: (1) progress reports on long-term major research projects; (2) final reports on short-term projects and (3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

CONTENTS

(Continued from Outside Front Cover)

EFFECT OF THE INCREASED BIRTH RATE ON SCHOOL ENROLLMENTS AND SCHOOL-BUILDING NEEDS

By J. F. THADEN
SECTION OF SOCIOLOGY AND ANTHROPOLOGY

DURING every year since 1941, Michigan has produced a bumper baby crop. In not a single year previous to 1941 had as many as one hundred thousand births been recorded in the state. In not a single year since 1940 have as few as one hundred thousand births occurred.

The Michigan Department of Health reports a total of 160,315 births in the state for the year 1947. This is 21,743 more births than occurred in 1946, and 48,758 more than in 1945. It is approximately twice the number of births registered in 1933. The figure for that year was 80,482.

During the 6 years from 1942 through 1947, 256,433 more babies were born than in the same 6-year period during the 1930's. This increase in the birth rate will obviously necessitate expanded school facilities. If one estimates on the basis of 30 pupils a room, 8,548 new classrooms would be required. If the average cost of a new classroom is estimated at $20,000, this crop of war babies and postwar babies calls for an investment of 171 million dollars in new or additional school-room space.

The Michigan Public Education Study Commission in its Report of 1944 indicated the sad financial plight of Michigan's public school buildings. It estimated that about 99 million dollars was necessary for an adequate 10-year construction program for school buildings. Since that time, building costs have more than doubled and accumulated needs have increased until now the total school building demand would probably be in the neighborhood of 300 million dollars. During the next 20 years, the current need for additional classroom facilities in Michigan will be greatly accentuated by the unusually high birth rate of 1942 and subsequent years.

ARTICLE 31-1

The 160,315 babies born in Michigan last year will have entered kindergarten in 1953. Thirteen years later, that is, in 1965, a majority of them will have graduated from high school. Truly, the record of births during the 1940's provides proof of the magnitude of school enrollments and school building needs during the 1950's.

SIMILARITY BETWEEN BIRTH CYCLES OF WORLD WAR I AND WORLD WAR II

In the realm of demography, history is repeating itself. Some vital statistics compiled after World War II are following the pattern set by similar statistics after World War I. The years following World War I were noted for many marriages and many births. The average annual number of births in Michigan during the 7 years from 1924 through 1930 was 98,634, as compared with an average annual number of 73,912 births during the 7 years preceding our entry into World War II.

As a result of the large number of births after World War I, enrollments in the public schools of Michigan exceeded one million annually during the years 1929, 1930, 1931, and 1932. The peak was reached in 1932 with a total enrollment of 1,049,505.

Similarly, the unusually large number of births following World War II will boost enrollments in the public schools of the state beyond the one-million mark again. It will probably exceed the one-million mark next year and also each year during the 1950's. It will probably attain the unprecedented figure of 1,200,000 in 1956.

The number of births in Michigan, by years, from 1920 to 1947 is given in Table 1.

TABLE 1—*Number of births in Michigan: 1920-1947**

Year	Births	Year	Births	Year	Births
1920	92,245	1930	98,882	1940	99,106
1921	96,035	1931	90,547	1941	107,498
1922	90,042	1932	85,254	1942	124,068
1923	92,956	1933	80,482	1943	125,441
1924	98,187	1934	83,944	1944	113,586
1925	98,983	1935	87,403	1945	111,557
1926	98,289	1936	88,457	1946	138,572
1927	99,940	1937	91,566	1947	160,315
1928	97,462	1938	96,962		
1929	98,695	1939	94,432		

*Annual Reports of Michigan Department of Health.

Practically all children who will be in school in 1952 will have been born in the 13-year period from 1935 through 1947 when a total of 1,438,963 were born. This is nearly a quarter of a million more births than took place during the 13-year period 1915-27. Furthermore, a constantly increasing proportion of those born survive the hazards of childhood and live to enter school. It is also quite likely that a constantly increasing proportion of children will continue in school until their graduation from the eighth grade and from the twelfth grade. It is therefore probable that the enrollment in the public schools of Michigan during the 1950's may be more than one-fifth greater than the previous maximum enrollment of 1,049,505 in 1932.

THE RISING BIRTH RATE

The birth rate is commonly expressed as the number of births during the year per one thousand population. The birth rate in Michigan in 1946 was about 24.3. This is higher than in any year since 1921. The population figures for 1940, 1930, and for other census years are known, and the birth rate for those years can therefore be readily and accurately determined. For inter-censal and post-censal years, it is necessary to make estimates of the population in order to compute reasonably satisfactory vital-statistics rates.

The State Department of Health estimates the population of Michigan for 1946 to have been 5,708,415. This estimate is based on a formula devised by Hope Tisdale Eldridge of the Population Division of the United States Bureau of the Census.[1] The estimated population of Michigan and of its counties and urban centers for 1947 has not yet been completed. However, one may tentatively assume that the growth of population in Michigan during 1947 was at least as great as the average annual increase between 1940 and 1946, which was 72,369. On this basis, the estimated population of Michigan for 1947 would be 5,780,784. This also means that the birth rate for Michigan in 1947 would be 27.5. This is the highest birth rate for any year during the past 50 years, and probably the highest in the history of the state.

The birth rate is frequently affected by the marriage rate. Between 1945 and 1946, marriages in Detroit increased 66 percent, one of the greatest increases among the large cities of the country. Mar-

[1] U. S. Bureau of the Census, Population—Special Reports, Series P-47, No. 4, "Suggested Procedures for Estimating the Current Population of Counties," April 30, 1947.

riages in Michigan reached an all-time high in 1946. This helps to explain why births in Michigan reached an all-time high in 1947.

At the moment it seems that the rising tide of births probably reached a peak last fall and one can reasonably expect the birth rate to drop during the coming months and years. But the number of children seeking admission to our schools is rising and will continue to rise for years. It is estimated that a peak of approximately 1,200,000 will be enrolled in kindergarten through the twelfth grades of our public schools in 1956. This estimate, if accurate, will be 250,000 more than were enrolled last year, and will require 8,400 classrooms with 30 pupils to a room.

ENROLLMENT IN PUBLIC SCHOOLS

The enrollment in kindergarten and in each of the 12 grades of the public schools of Michigan in 1946 and 1947 are as follows:

	1946	1947
Kindergarten	85,511	92,043
First Grade	91,442	93,544
Second Grade	84,762	84,159
Third Grade	79,052	82,749
Fourth Grade	75,684	77,363
Fifth Grade	72,828	73,895
Sixth Grade	68,982	71,554
Seventh Grade	68,525	68,735
Eighth Grade	67,100	65,284
Ninth Grade	66,417	64,079
Tenth Grade	60,616	59,292
Eleventh Grade	49,802	51,769
Twelfth Grade	41,736	45,882
Total	946,627	972,360

Most of the pupils who were in the first grade in 1946 were in the second grade in 1947, are in the third grade this year, and will be in the fourth grade next year.

In making estimates of enrollments, it is here assumed that the ratio of enrollment in the first grade in 1946 to enrollment in the second grade in 1947 will remain essentially the same year after year. Similarly, the assumption is made that the ratio of enrollment in the second grade in 1946 to enrollment in the third grade in 1947 will remain constant. The same assumptions are also made regarding the estimated enrollments in each of the other grades. Thus, the number of enrollees by grades in 1946 and 1947 serves as the basis for

estimating enrollments in grades 3 through 12 in 1948, in grades 4 through 12 in 1949, and so on for succeeding years until the present crop of enrollees will have graduated from high school by 1958.

Estimates of future enrollments in various grades can be made more accurately on the basis of pupils enrolled in the public schools of the state in 1947 than can estimates of the number of pupils who will enter school this year or in the coming years. However, the assumption in these calculations is that the ratio of births in 1941 to enrollment in kindergartens of public schools in 1947, namely 85 percent, will remain much the same during the next 10 years. On this basis, the 125,441 births in 1943 will result in an enrollment of 106,625 in kindergarten in 1949, and the 160,315 births in 1947 will result in an enrollment of 136,268 in kindergarten in 1953.

Table 2 shows the enrollment in the elementary grades, in grades nine through twelve, other enrollments, and total enrollments in the public schools of Michigan in 1930-1947, and estimated enrollments in each of these categories by years from 1948 through 1957. The table indicates that the enrollment in kindergarten through the eighth

TABLE 2—*Enrollment in the public schools of Michigan, 1930-1947, and estimated enrollment, 1948 to 1957*

Year	K—8	9—12	Other	Total
1930	838,790	166,999	20,295	1,036,084
1931	832,523	185,697	30,213	1,048,433
1932	816,494	202,215	30,796	1,049,505
1933	722,347	200,910	34,647	957,904
1934	702,903	199,506	24,973	927,382
1935	713,724	206,755	23,388	943,867
1936	709,104	214,510	28,678	952,290
1937	706,169	214,883	21,267	942,325
1938	705,171	229,383	25,273	959,827
1939	691,790	242,859	33,203	967,852
1940	683,130	248,662	41,984	973,737
1941	677,411	246,455	36,346	960,212
1942	673,723	238,478	73,438	985,643
1943	675,811	220,949	32,600	929,360
1944	685,421	211,168	30,452	927,041
1945	688,058	213,901	33,326	935,285
1946	693,886	218,571	34,170	946,627
1947	709,326	221,023	42,011	972,360
1948	740,820	213,606	38,000	992,430
1949	773,750	210,050	35,000	1,018,800
1950	792,780	209,870	35,000	1,037,650
1951	799,130	215,190	35,000	1,049,320
1952	827,150	219,410	35,000	1,081,560
1953	871,420	226,220	35,000	1,132,640
1954	903,290	230,320	35,000	1,168,610
1955	925,210	228,173	40,000	1,193,380
1956	927,480	230,770	40,000	1,198,250
1957	903,300	241,500	40,000	1,184,800

grade will steadily increase from 709,326 in 1947 to 927,480 in 1956, an increase of 218,154.

It is estimated further that the present enrollment of 221,023 in grades nine through twelve will decrease steadily for the next 3 years, reaching 209,870 in 1950, after which it will show a fairly continuous increase, rising to 241,502 in 1957. However, the peak enrollment in grades nine to twelve will probably not be reached until 1964, when the record crop of 1947 babies will be graduating from the twelfth grade.

In 1947, the number of students classified as "Others" enrolled in the public schools of Michigan totaled 42,011. It is conservatively assumed that this figure will remain about the same, that is, from 35,000 to 40,000. However, these figures will be much larger if and when the 13th and 14th grades materialize in our public school system.

Table 2 indicates that the present enrollment of 972,360 in the public schools of Michigan will increase to a figure exceeding one million in 1949, and that in 1953 and for at least 7 years thereafter it will exceed the all-time record of 1932. The peak enrollment will probably be reached about 1956, when it is conservatively estimated that 1,198,250 pupils will be enrolled in the public schools of the state. Thus, in about 8 years, if these estimates are correct, the student population pressure will be greatest and many school plants will be "bursting at their seams" unless school electors are adequately informed of their educational responsibilities to the children of their communities.

The estimates of probable enrollments in kindergarten in 1948 and in succeeding years, and estimates of the holding power of the public schools of future enrollees, are conservative for two reasons. First, the infant mortality rate will probably continue to drop, so that an increasing number of babies will survive to the age of school admittance. To illustrate, in 1940, about 95,700 babies out of 100,000 survived to the age of 5. In 1947, about 900 more per 100,000 survived to the age of 5.

Second, an increasing proportion of children in all grades in recent years have been passing into the next higher grades in successive years. This tendency can be expected to continue. Certainly the proportion of eighth-graders who enter the ninth grade should in-

crease as a result of the enactment last year of a law which requires school attendance up to the age of 16. Heretofore, thousands of rural boys and girls ended their formal schooling on completion of the eighth grade, although they were under 16 years of age.

POPULATION CHANGES BY COUNTIES SINCE 1940

The task of providing new or additional school buildings for the large aggregation of war and postwar babies will be much greater in some counties than in others. Population growth is very uneven in Michigan. In 47 counties, the population is very probably less now than it was in 1940, while in 36 counties there seems to have been some increase in population, in several of them an increase of more than 30 percent. This is the conclusion drawn from a comparison of the estimated populations of counties in 1946 with their populations in 1940.

In the 47 counties which, according to this estimate, showed a decline in numbers, the population was 1,069,437 in 1940 and only 981,718 in 1946. This is a decrease of 87,719 or 8.2 percent. On the other hand, the 36 counties which showed an increase had a total population of 4,186,669 in 1940 and 4,726,697 in 1946. This is an increase of 540,028, or 12.9 percent.

The population in Muskegon County increased from 94,501 in 1940 to 119,586 in 1946, an increase of 26.5 percent. In Washtenaw County, the population of 80,810 in 1940 increased to 106,301 in 1946, an increase of 31.5 percent. Oakland County's population of 254,068 in 1940 zoomed to 337,009 in 1946, an increase of 32.6 percent. In the relatively short time of 6¼ years (April 1, 1940 to July 1, 1946) the population of Macomb County climbed from 107,638 to 155,394, an increase of 44.4 percent. In these four counties alone, the population increased 181,273 from 1940 to 1946, and it undoubtedly increased still more in 1947. These figures give clues as to the localities where need for additional school buildings is likely to be greatest now and in the very near future. In general, there is a close correlation between total population change and changes in school census population and in school enrollments.

COMPARISON OF POPULATION INCREASE IN RURAL PORTIONS OF COUNTIES WITH THAT IN URBAN CENTERS

The question arises as to whether the need for school buildings is likely to be greatest in the rural areas or in the urban centers of those counties in which phenomenal increases in population have taken place since 1940. Answers to this question are presented in Table 3 for Muskegon, Washtenaw, Oakland, Macomb and other counties with urban centers, which show an estimated population increase of 10 percent or more.

Twenty-two Michigan counties are entirely rural, that is, they have no urban population, or no incorporated places of 2,500 or more inhabitants. Apparently 18 of them had a smaller population in 1946 than at the time the 1940 census was taken. These 18 counties are: Alcona, Antrim, Arenac, Benzie, Crawford, Gladwin, Kalkaska, Keweenaw, Lake, Leelanau, Missaukee, Montmorency, Oceana, Ogemaw, Ontonagon, Oscoda, Otsego, and Sanilac. There was an actual decrease in the total number of farms between 1940 and 1945 in 13 of these 18 counties and only a slight increase in the others. This indicates that a decline in farm population may have been the principal reason for the decrease in the total population. At least the problem of school building needs is different in these counties from that in counties mushrooming with new school enrollees.

Four other counties are also entirely rural. Two of them, Clare and Osceola, showed very slight increases in population from 1940 to 1946, while Iosco and Roscommon, the other two counties, made substantial increases. The population in the former of these two

TABLE 3—*Population increase since 1940 in specified counties*

County	Percentage Increase in Population, 1940-1946	
	Rural	Urban
Bay	10.6	9.9
Berrien	15.5	19.7
Calhoun	13.5	13.7
Clinton	10.4	7.9
Grand Traverse	12.0	10.2
Macomb	40.5	49.1
Midland	19.3	25.0
Muskegon	27.7	26.0
Oakland	47.0	21.5
Washtenaw	29.2	33.8
Wayne	11.2	11.2

counties increased from 8,560 in 1940 to 10,012 in 1946, an increase of 17 percent. The population of Roscommon during the same interval increased from 3,668 to 5,261, an increase of 43 percent.

In the 11 counties in which the total population increased 10 percent or more between 1940 and 1946, the increase was greater in the urban center or centers than in the rural areas for Berrien, Calhoun, Macomb, Midland, and Washtenaw counties, while the increase was greater in the rural areas than in the urban center or centers for Bay, Clinton, Grand Traverse, Muskegon, and Oakland counties. In Wayne County, the population increase was essentially the same for the two areas. Thus, in five rapidly growing counties, the population increase was greater in the urban areas, while in five counties the increase was greatest in the rural areas, presumably in the suburban or so-called "fringe" areas.

The only county in which the difference in population increase is much greater in one area than in the other is in Oakland County, where the population increase in its seven urban centers (Berkley, Birmingham, Clawson, Ferndale, Pleasant Ridge, Pontiac, Rochester, and Royal Oak) was 21.5 percent, while in the unincorporated or rural areas of the county, it was 47 percent. A study of 140 school districts in this county indicates that rapid population growth in recent years has been a strong contributing factor in the great variation in taxes. In 1945, property tax on $4,000 assessments when equalized, ranged from $14 to $118.[1] Uneven population changes tend to increase tax variation and inequalities in educational opportunity.

POPULATION TREND INDICATED BY SCHOOL CENSUS

Increased needs for additional school buildings, equipment, and teachers in specific school districts can be gaged by increases from year to year in the school census. According to the United States Census of 1940, 81 percent of the children of school age (5 to 19 years inclusive) in Michigan were attending school that year. Therefore, an increase in the school census within a school district from one year to the next of 37 or 38 should normally result in an additional classroom and an additional teacher to care for the enlarged enrollment. Some primary school districts in the Detroit metropolitan region increased in school population almost this rapidly annually

[1] J. F. Thaden, "Tax Variation in Oakland County and Trend Toward Equalization of Taxes by Means of Enlarged School Districts." Michigan Agr. Exp. Sta. Quart. Bul. 30: 317-338, February 1948.

during the past 10 years. The Troy-Union School District in Troy Township of Oakland County had a school census of 84 in 1936; by May 1947 this had increased to 231. During the same 11-year interval, the school census in the Southfield School District of Southfield Township in Oakland County had increased from 50 to 338, and in Brace School District in the same Township from 90 to 528. Such phenomenal increases in school census populations are taking place in scores of primary school districts adjacent to our larger cities and are likely to continue for at least another decade.

CHILDREN OF PRE-SCHOOL AGE

A law passed by the Michigan legislature in 1944 provides for the enumeration of pre-school children at the time the school census is taken. Only four other states have such a law, namely, Louisiana, Minnesota, New York, and Nevada. (In the latter state, enumeration of pre-school children is permissive.) This serves as an excellent measure for determining school budgets and equipment needs some years in the future.

The completeness of the enumeration of children by school enumerators may be determined by a comparison of their figures with the number of births from May to May as recorded by the State Department of Health. For the state of Michigan as a whole, such enumerations were 84 percent complete for those under 1 year of age for 1944, 1945, and 1946. The percentage was probably higher for those who were 1, 2, 3 or 4 years of age. The completeness of enumeration probably varies considerably but could be readily determined where school districts and vital statistics districts are coterminous or where several of one type coincide with one of the other type. Enumeration of children of pre-school age annually enables school boards and administrators to predict initial enrollments for the following September and successive Septembers and thereby make necessary plans accordingly.

SUMMARY

The wave of new school children in Michigan is not peculiar to this state. It is nation-wide. The United States Census Bureau predicts a 300,000-child increase in first-grade enrollments next September. That agency expects that the number of new school children

will roll up to a total of 3,750,000 in 1953, after which a decline is anticipated. The predicted rise and eventual decline in school enrollment in Michigan can be expected to follow much the same pattern as in all states. However, the citizens of Michigan have an advantage over those in a majority of states in the relative completeness and accuracy of annual school census enumerations, and especially in the actual enumeration of children of pre-school age. They can thereby foresee when the further strain on our school facilities will be greatest and can, if they will, prepare adequately for its arrival. It is possible to have the necessary classrooms, equipment, and teachers ready for new enrollees. To do this, educational leaders in every county and community of the state should prepare for their respective service areas tables similar to Table 2, on the basis of which plausible 5- and 10-year programs for school building and teacher needs can be wisely formulated.

TRAPS FOR THE COLLECTION AND DISTRIBUTION OF POLLEN IN ORCHARDS

By J. C. KREMER
SECTION OF HORTICULTURE

THE PROBLEM of obtaining a good set of fruit in orchards planted to one variety has always been somewhat difficult because varieties suitable for cross-pollinating are lacking in the immediate vicinity and bees and other insects are not able to spread sufficient pollen of another variety over a large area.

Several practical methods are in use today that have overcome this difficulty to some extent, but, on the whole, they are rather labo-

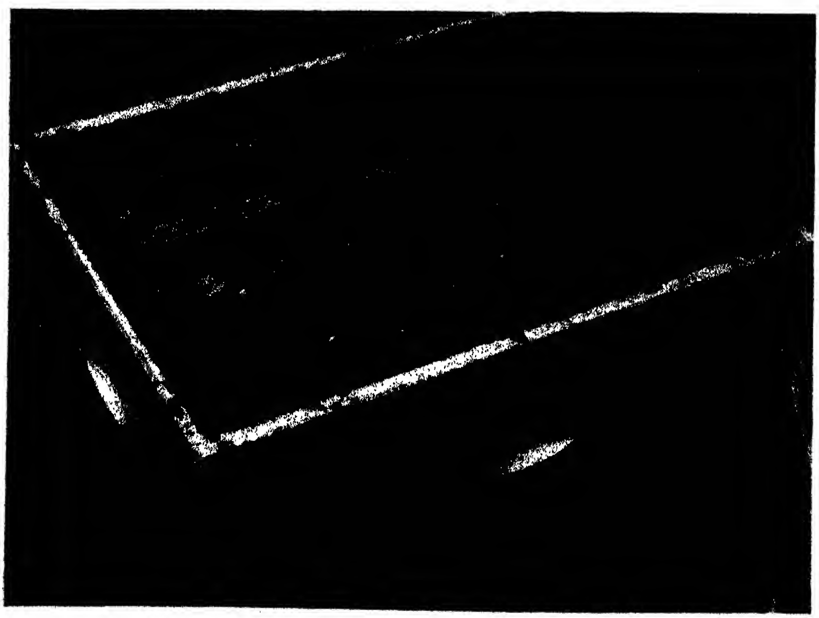


Fig. 1. Hive with cover removed to show typical strong colony with sufficient bees to gather large quantities of pollen and provide good pollination.

ARTICLE 31-2

rious, time-consuming, and expensive. The grafting of branches and the planting of trees of a suitable cross-pollinating variety in the orchard have provided practical solutions. Bucket bouquets in sufficient numbers have also proved effective, but they are only a temporary solution and the securing and handling of branches is considerable bother. Hand pollination, when properly performed during suitable temperatures, is quite effective, though rather expensive in the long run. The use of airplanes, pollen bombs, and water sprays as methods of applying pollen have usually resulted in failure. (Fig. 1.)

A recent addition to the above-mentioned successful methods is the use of pollen-collecting and pollen-distributing traps that employ the efforts of the bee. The principle involved is the collecting of fruit pollen from the pollen-gathering bees as they enter the hive, and conveying it to blossoms by the outgoing bees.

THE POLLEN-COLLECTING TRAP

This device is used in the hive entrance to remove the pollen pellets from the legs of the bee as it enters the hive. The trap consists of a perforated metal plate or screen 14⅜ inches by 3 inches, with 13/64-inch perforations. The measurements given are for the standard 10-frame hive and can be varied to suit 8-frame hives or others that do not conform to these lengths. It is sometimes advisable to shorten the overall length ⅛ inch to ¼ inch to allow for variation in hive width by adjusting the end blocks before fastening to the screen. Number 18- or 20-gage sheet copper is desirable, as it is non-rusting. Other metal sheeting can be used if desired, though its lasting qualities are not so good. This perforated metal screen is fastened to two triangular wooden blocks ½ inch by 3 inches by 3⅜ inches at each end of the metal screen. The screen, being 3 inches in width, leaves a space at the base of the triangle for the insertion of the pollen-collecting tray and wire screen receptacle that is used to catch the pollen pellets as they are scraped from the legs of the bee when it passes through the screen to the hive (Figs. 2 and 3).

The pollen tray should be made of 24-gage, non-rusting plated or galvanized tin that is easily crimped at the edges. The tin should be cut to 13⅞ inches by 2¾ inches, which allows for a lip or side walls ¼ inch high to form the tray. It is necessary to use a wire guard screen to keep the young bees from removing the pollen pellets that fall into

Fig. 2. Close-up view of pollen-collecting trap in position at entrance to hive. Bees cannot enter hive except through upright screen which removes the pollen pellets. Position of tray and guard screen allows ample clearance for ventilation and passage of bees.

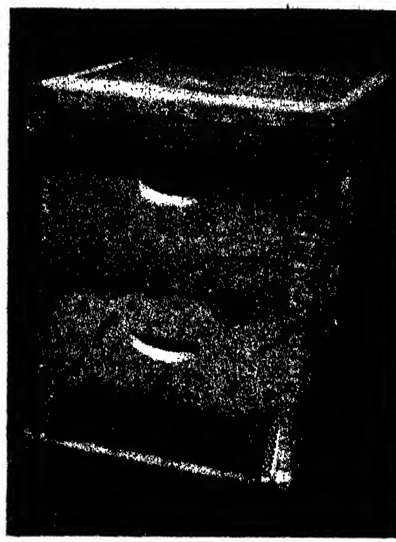


Fig. 3. Front view showing clearance behind screen and tray to entrance to hive.

the tray. They could remove the pollen if it were left unprotected. Common 6-mesh, 22-gage wire cloth cut to ⅛ inch less than dimensions for the tin tray, and crimped in a similar manner, should be inverted over the tray.

PRECAUTION: 6-mesh (6 openings to the linear inch) screen only should be used, as anything smaller in number prevents the pollen pellets from falling through the screen, and larger mesh or openings allow the bees to rob the tray of its contents.

The position of the pollen tray should be half inside and half outside the upright collecting screen, as some pellets fall inside and some outside the screen. Sufficient space should be left between the pollen tray and hive entrance to allow for good ventilation and free movement of bees.

WHEN TO USE POLLEN-COLLECTING TRAP

For apple varieties which blossom late in the spring, such as Delicious, McIntosh, and Northern Spy, pollen may be collected from varieties that bloom earlier or precede the blooming of the variety

for which the pollen is intended. Too great a lapse between gathering and application should be avoided if necessary. The pollen-collecting traps can, therefore, be set in the entrance of the colony when the bees are placed in the orchard to service these earlier varieties, or through the entire fruit-blooming period if necessary. If the traps are properly made, no trouble should be experienced in placing them in front of the entrance. Any crevices or holes in the hive other than the screen itself will soon be discovered and used, lowering the efficiency of the trap to that of an obstruction to flight. Some confusion will exist for the first 30 minutes, but this does no harm. Though the traps obtain considerable pollen (12 to 20 percent of that collected), sufficient quantities pass through the screen for the needs of the colony.

Variations in the color of the pollen may be expected, as dandelions, wild flowers, bushes and trees may also have pollen available at this season of the year. The fact that foreign pollen is present along with the fruit pollen is also a good indication that the colonies gathering the fruit pollen are making a thorough search of all varieties of fruit bloom that may be present in the locality. This usually insures a sufficient variety of suitable cross-pollinating pollens in the mixture to offset any foreign or incompatible fruit pollen that may be present. It might be recalled that in the old-fashioned farm orchard, where nearly every apple tree was of a different variety, there was always an overlapping of the blooming period of some of the varieties at one time or another. Few pollination problems existed in such orchards, and they usually set fruit.

It might also be added that on certain days when temperatures are too low for favorable activity on fruit bloom, other blossoms such as those of dandelions will be at their optimum so that a preponderance of this foreign pollen may be found in the pollen trap. Dandelion pollen is easily recognized by its orange-yellow color as compared to the pale yellow of fruit pollen. Under these conditions the contents of the trap may be discarded, as any time spent in an attempt to eliminate it is time wasted. Inasmuch as most varieties are compatible with one another but differ as to blooming periods, a conglomeration of fruit pollen is desirable and usually acceptable for use on later varieties, providing proper precautions are taken to preserve its viability through proper handling and storage.

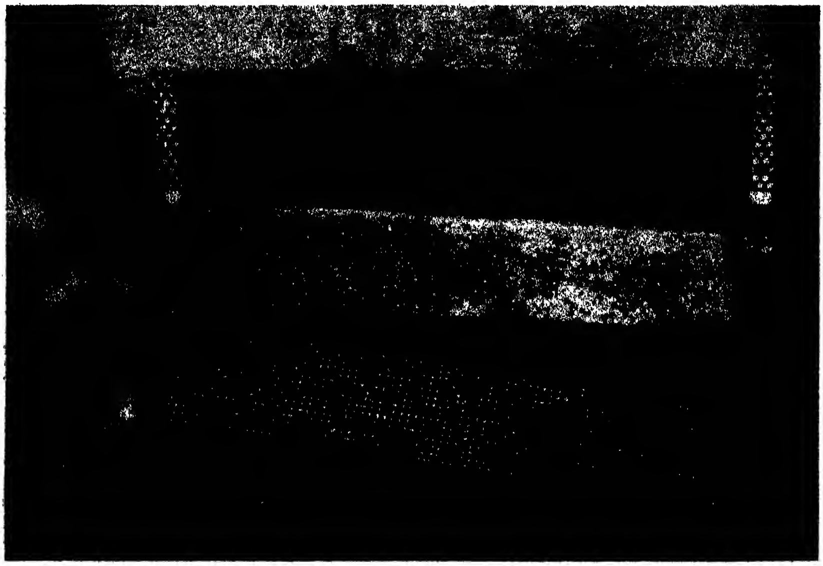


Fig. 4. Pollen tray and guard screen being removed without disturbing perforated metal sheeting. Pollen tray shows an average amount of pollen pellets obtained during several hours' use of trap.

MIXING AND STORAGE OF POLLEN

Pollen should be removed from the trays twice a day (Fig. 4.). This is accomplished by sliding the tray from beneath the collecting screen without removing the perforated screen itself. Remove the wire guard screen from the tray, pour the pollen into a container such as a fruit jar, and replace the tray in its former position. The pollen pellets should then be mixed with a diluent or carrying powder (lycopodium spores) in the ratio of about one to three parts lycopodium spores to one part pollen. This ratio should be adapted to the strength of the colony or the number of bees leaving the hive per minute, as a large number of bees passing through the mixture may create sufficient air disturbance to blow a considerable amount of the pollen mixture back in the hive if too high a ratio of the diluent is used. A starting ratio of equal parts of pollen and lycopodium spores is perhaps advisable, as more of the diluent can be added if necessary to attain the desired fluffiness for weaker colonies that do not disturb the mixture to such an extent. The color of the mixture is also a good indicator of

a proper ratio. The addition of one part pollen to one part of the very pale-yellow-colored lycopodium spores deepens the color to a pale orange.

Other diluents such as talc, cornmeal, starch, and flour are flaky in texture and when mixed with pollen have a tendency to adhere to one another in tiny lumps that prevent free flowing and distribution of the pollen grains. Lycopodium spores being dry, free flowing, and similar in size to the pollen grains, do not adhere to the pollen nor form lumps. This excellent diffusion should not be hampered by the addition of less suitable diluents in an effort to increase the amount of mixture available. As the pollen grains are easily damaged, the operation of reducing the pollen pellets in the fluffy carrying powder should be done in a gentle manner. Grinding or mashing should not be permitted. Mixing the material by hand in a bowl gives satisfactory results. A mechanical mixer can be made by fastening two 1- by 4-inch medium-soft brushes (bottle brushes) at the bottom of a small box having sloping sides and rounded bottom. The brushes should overlap. Two small wooden pulleys can be fastened to the ends and connected with a crossed rubber band. A small handle enables the operator to revolve the brushes at a moderate speed. If eight or ten

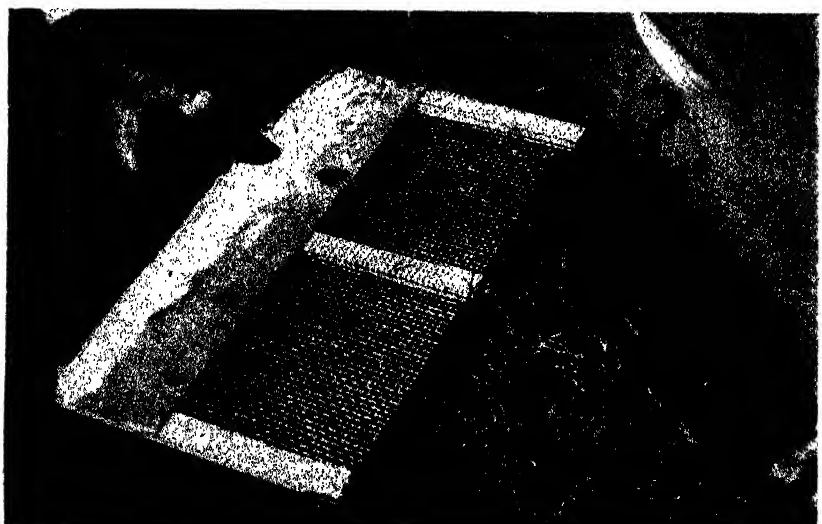


Fig. 5. The pollen-distributing trap about to be pushed in entrance of hive. The pollen and lycopodium mixture, in the form of a dust, shows the normal position it should occupy in the curvature of the metal lip.

colonies are using the traps, considerable amounts of pollen can be expected.

The pollen thus gathered and mixed should be stored under dry conditions at 34° to 36° F. if it is not to be used immediately, as it loses its viability quite rapidly, even under the best of conditions. Fruit jars make good storage containers, provided the lid is left loose.

THE POLLEN-DISTRIBUTING TRAP

The pollen-distributing trap (Fig. 5) was devised to dust the outgoing bees with the pollen previously gathered, by forcing them to scramble upward through the mixture as they leave the hive. A baffle

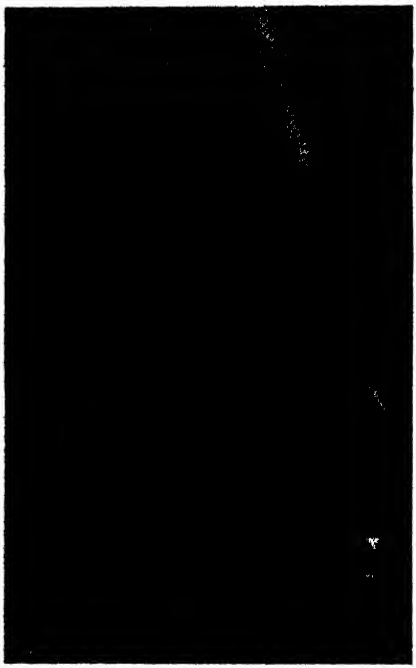


Fig. 6. The distributing trap in position after being pushed into entrance of hive. Space between hive body and metal plate should not be greater than ¾ inch to 1 inch. Incoming bees are using lower space under trap. Outgoing bees, nearest to hive, show results of dusting they received when passing through pollen mixture.

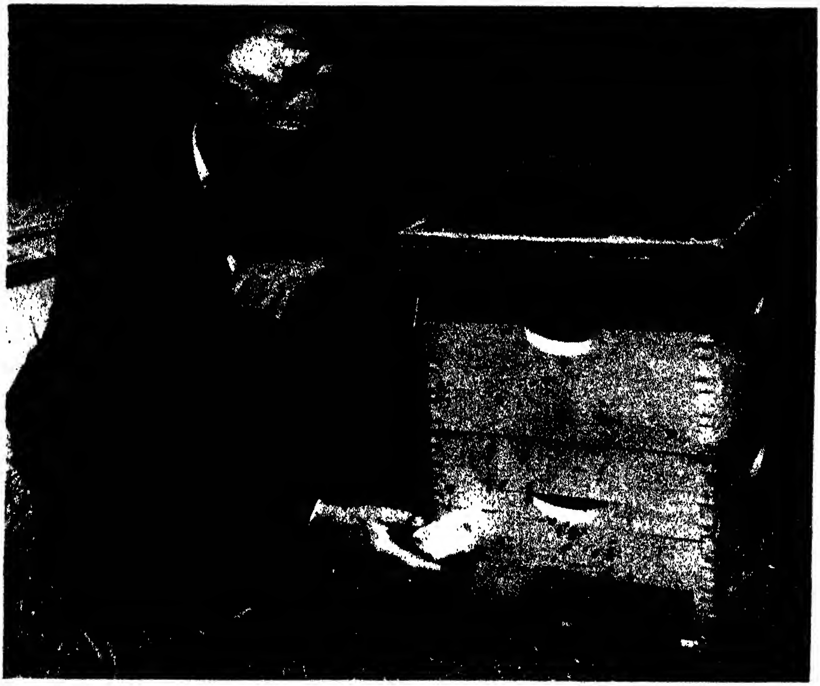


Fig. 7. Pollen mixture being sprinkled in space between trap and hive body. This should be done quickly, as indicated, from side of hive to avoid irritating bees or interfering with bee flight.

plate of sheet aluminum, or other highly-polished metal, 6 inches by 14½ inches, is bent at right angles the long way of the metal, having a curved—**not square**—center line at least an inch across the perpendicular sides. The purpose of this curve in the metal strip is to bring about the scrambling, flying motion that is caused by the narrow slippery surface between hive and baffle plate, so care should be used when bending the metal to shape. The metal plate is then fastened to three wooden strips ½ inch by ⅜ inch by 8 inches. The entrance space to the colony is ¾ inch on standard bottom boards. The metal plate divides this space to equal dimensions. The rest of the space on the wooden strips projecting beyond the tin should be covered by a 6-inch by 14½-inch wire cloth screen, having six mesh to the linear inch.

This completes the trap, and when it is placed in the entrance, the 3-inch upcurled metal plate should be within 1 inch of the front

of the hive (Fig. 6). This arrangement directs the incoming bees to the space under the trap and to the back of the hive. The outgoing bees, traveling downwards, are diverted towards the front of the hive by the screen and through the pollen mixture that is sprinkled in the curve of the tin. Not more than a teaspoonful should be distributed in the trap at one time (Fig. 7). A large salt shaker, or a can with holes punched in the lid, makes an ideal device for sprinkling the pollen mixture into the trap.

If too much pollen is added, the bees become blinded and heavy, which causes them to alight nearby to cleanse themselves of most of the pollen before continuing their flight. The rate of flight, or the number of bees leaving the hive per minute, will determine the frequency with which the pollen will have to be replaced. Package bees, with a rate of 15 to 40 bees a minute, will need much less attention than colonies flying at the rate of 150 to 250 a minute. This latter rate requires the constant circulation of an operator from hive to hive to replace the pollen as it is used.

To obtain maximum efficiency from the distributing traps, the colonies to be used for these hard-to-set blocks of fruit should not be moved to the orchard until "full bloom" and a temperature of 65° to 75° F. is expected for the day. In re-orienting themselves to the new location, the flying radius of the bees is reduced to the immediate vicinity for a day or two.

This maneuver forces the bees to pollinate the blossoms for which the pollen was intended, and not those of the surrounding countryside. If sufficient bees and traps are used for a given acreage under these conditions, 1 or 2 days should suffice to set the crop.

SUPPLEMENTARY SUGGESTIONS

It should not be assumed that the casual mention of placing the traps in the entrances of bee hives means that the operation is not fraught with some pointed possibilities when the operator is nervous, slipshod, rough, or when a strain of bees is encountered that tends to be what is called "touchy." A bee veil should be worn and a lighted smoker should be at hand at all times, as smoke is the only means of controlling the bees when they are excited. **Note:** No wool of any kind should be used as fuel for a smoker. A puff or two in the entrance before operations proceed is usually sufficient to enable the operation

to be performed in comfort and safety. Smoker and bee veil may be purchased at any bee supply company.

Lycopodium spores can be obtained from the S. B. Penick Company, 50 Church Street, New York 7, New York, or The Michigan Orchard Supply Company, South Haven, Michigan.

Arrangements have been made with the Dunkley Manufacturing Company, Lake Street, Kalamazoo, Michigan, to manufacture this equipment. It may be purchased from that company, if it is desired, though it can be made by anyone wishing to construct it.

CONSUMER PREFERENCE TESTS FOR IMITATION AND PURE FLAVORS IN ICE CREAM

By P. S. LUCAS
SECTION OF DAIRY

SCORE CARDS have been used for at least 50 years as a device for measuring quality in dairy products. These have been standardized in several states, and, for the scoring of ice cream, a maximum of 45 points is allowed for flavor. While this allowance applies to that flavor imparted to the product by agents such as extracts, it also includes the flavor, good or bad, given the ice cream by the dairy products used in the mix. It is therefore fallacious to consider the extract used in ice cream as all-important, since the heavy allowance permitted flavor on the score card must be shared by the flavor of the other products used.

Flavors and extracts are used to enhance the flavor supplied by fruit or other products. This is desirable, owing in part to the effect of cold temperatures upon the sensory nerves registering flavor. Low temperatures reduce volatilization of flavors and result in dull recording of the flavor on the nerve endings. An extract reinforces the flavor supplied by the fruit. The cost often cuts the use of optimum amounts of flavors and the same reasoning applies much more forceably to the use of fruits. The use of excessive amounts of fruits in ice cream increases the coarseness of the ice cream, cuts the cream's ability to assume overrun, and lowers its freezing point. The customary amounts of fruits to use range from 1 to 3 quarts for 5 gallons of mix.

Flavors used to reinforce fruits may be composed of materials derived from the fruits themselves, in which case they are referred to as true fruit extracts, or they may be composed of synthetic products and mixtures of oils, ethers, chloroform, alcohol, etc. The flavor of the fruit is usually contained in the essential oil of that fruit. To date, some 10 to 14 known ingredients have been isolated, each of which

ARTICLE 31-3

modifies and blends with the other individual ingredients. Many different flavors contain the same ingredients but in different proportions. In this study, an answer was sought as to whether the public prefers a pure flavor or an imitation flavor in ice cream. The search was limited to two flavors, vanilla and strawberry.

VANILLA

The taste of vanilla extracts depends largely upon the locality in which the vanilla bean was grown. According to the United States Pharmacopeia, a single-strength vanilla must contain the extractive matter from 13⅓ ounces of beans per gallon. Stronger extracts may be made, usually in multiples of the amount used in single strength, and are referred to as concentrates. These are pure extracts, whether of single or multiple strength. An imitation flavor, according to the standards, is one made up entirely of synthetics or of pure vanilla with reinforcement, as with added vanillin and coumarin. In this report, only pure and imitation liquid extracts were used, although powdered flavors and emulsions are on the market.

Isolated in 1860 by German chemists, vanillin has a wide usage in flavors. Its flavor somewhat resembles that of vanilla. It is found in all vanilla beans and is partially but not wholly responsible for vanilla flavor. It may be made synthetically from oil of cloves, coniferin, or sulfite liquor, and is used frequently to reinforce vanilla extracts and to make imitation vanilla. The so-called Tonka blend vanilla is made by adding to vanilla extract the extract of the Tonka bean or by the addition of synthetic coumarin, which is the flavoring principle of the Tonka bean. It lends an aromatic flavor but does not closely resemble vanilla. This modification is said to be used chiefly in the South, although before the passage of the flavor law, it was used in Michigan. Either of these two synthetics, when added to pure vanilla, greatly increases the flavoring power of the vanilla. Formerly it was claimed that pure flavors would freeze out of ice cream and that the addition of these synthetics would prevent this. That claim has been disproved, however.

TESTS WITH VANILLA

Ice cream was prepared with five types of vanilla. These types and the amounts used for 5 gallons of mix were as follows:

1. Pure Mexican-Bourbon bean extract, 4 ounces.
2. Pure vanilla reinforced with vanillin, ¾ ounce.
3. Fortifier, 4 ounces.
4. Pure concentrated vanilla reinforced with ¼ ounce coumarin per gallon.
5. Imitation vanilla, 2 ounces.

Number 1 contained the extractive matter from 60-percent Bourbon beans and 40-percent Mexican beans. Number 2 was a Bourbon and Mexican bean concentrate containing 1 ounce of vanillin per gallon. Number 3 was an imitation composed of vanillin, St. John's bread, ethers, esters, gum, coloring, alcohol, and glycerine. Number 4 was a concentrate of combined Bourbon and Mexican beans containing 1 ounce of coumarin per gallon. Number 5 was an imitation made up of the same materials as number 3 but in different proportions.

The ice creams were made from the same mix and were of a standard such as is commonly used in this state. A sample of each was placed on a paper plate with a number. These plates were passed out to individuals together with a slip of paper, and they were asked to carefully sample each one by themselves and to rate them according to quality. They were asked to do this individually to eliminate the possibility of their being influenced by the opinions of others. While it is doubtful that these scorers gave the matter as careful attention as would a trained judge, it is believed that in most cases a considered opinion was given.

Forty-four persons sampled each of the five types. A record was kept of the number of people placing each type first, second, third, fourth, or fifth. This is referred to as its placing. Each placing was then rated by multiplying the number of people placing it by the placing itself. Thus, if three people placed number 1 sample fourth, the three was multiplied by four to get the rating. That sample having the lowest rating, therefore, would rate first. These ratings are reproduced in Table 1.

The number 1 sample, which was pure vanilla, easily placed first with 114 points. The number 5 sample, imitation vanilla, placed second with 128 points. The number 2 sample, which was pure vanilla reinforced with vanillin, placed close to the number 5 sample, with 134 points. The number 4 sample, which was pure vanilla reinforced

TABLE 1—*Results of scoring vanilla ice creams*

Rating	Sample number									
	1		2		3		4		5	
	Judges so rating	Total score	Judges so rating	Total score	Judges so rating	Total score	Judges so rating	Total score	Judges so rating	Total score
First	11	11	13	13	5	5	5	5	10	10
Second	13	26	5	10	10	20	8	16	8	16
Third	10	30	5	15	6	18	14	42	9	27
Fourth	3	12	9	36	14	56	8	32	10	40
Fifth	7	35	12	60	9	45	9	45	7	35
Total	44	114	44	134	44	144	44	140	44	128

with coumarin, was a poor fourth and the number 3 sample, which was a fortifier, placed last.

These tests were made entirely by the general public and they would indicate that there are many people who dislike imitations. It would perhaps not be too farfetched to conclude that people like those products to which they have become accustomed. In the pastry industry, many imitation flavors are used, and many imitation flavors are sold to the housewife for use in the home. It is perhaps not too far from the truth to say that a good imitation may be better than a poor extract. A pure extract may be made from Tahiti beans which will yield a flavor characteristic of the vanilla extract but inferior to many good imitation flavors. The results of the scoring, however, show that a majority of the people prefer a pure extract so far as vanilla is concerned and that the manufacturer of ice cream hoping to stay in business will probably find the use of a pure extract to be more economical than use of an imitation flavor in the long run. He will find it still more profitable if he extensively advertises the fact that he uses nothing but pure flavors. It is a goal which the larger, more progressive manufacturers have set as their aim and toward which they direct their advertising.

TESTS WITH STRAWBERRY

Following the procedure described in studying vanilla extracts, the public taste regarding strawberry flavorings was scrutinized.

The following extracts were added to a strawberry ice cream containing 3 quarts of strawberries for 5 gallons of mix. Such an extensive

use of fruit, it is realized, would make less noticeable the type of strawberry extract used to reinforce the flavor and might therefore make less noticeable differences between the types used.

1. True fruit strawberry extract, 3 ounces.
2. A second true fruit strawberry concentrate, 1 ounce.
3. A strawberry flavor, single strength reinforced, 3 ounces.
4. Imitation strawberry flavor, 2 ounces.
5. A special imitation strawberry, 3 ounces.

Number 1, listed as a true fruit strawberry, actually contained 75 percent true fruit strawberry plus 25 percent true fruit raspberry. Both of these ingredients were concentrates. The second was also a true fruit strawberry concentrate. Number 3 contained a natural strawberry concentrate reinforced with a natural raspberry concentrate. Number 4, the strawberry imitation, contained imitation oil of strawberry, natural oil of lemon, ethers, natural raspberry concentrate, and alcohol. Number 5, a special formula imitation, contained natural raspberry concentrate, imitation oil of strawberry, oil of orris, other essential oils, vanillin, acetic and other ethers, esters, aldehydes, sugar, glycerine and propylene glycol.

The scores obtained in judging the strawberry flavorings were divided, according to the judging personnel, into two classes, experienced and inexperienced. Scoring was done in a manner identical with that for vanilla. The latter, inexperienced scorers, placed number 1 sample, pure strawberry, with a score of 56, first. Number 2 sample, pure concentrate, rated second with a score of 67. Number 3, pure reinforced, scored 68. Number 4, imitation, scored 75 and number 5 placed last. This form of rating, it should be stated, places samples closer together than would a straight score card method of rating.

Since the scorers were inexperienced, however, it was impossible to use a rated scale such as given on the score card. Twenty-three inexperienced scorers were used to compose the inexperienced group. Fifteen scorers composed the experienced group. Their placings were 1, 3, 2, 4, 5, whereas that of the inexperienced group was 1, 2, 3, 4, 5. The scores given by the inexperienced group were respectively 32, 44, 45, 49, 55. Numbers 2 and 3, therefore, were extremely close and for all practical purposes, the rating of the two groups of scorers was the same. It will be noted that the imitation samples placed a poor

fourth and fifth. Since number 3 contained no imitation products but rather a true fruit strawberry flavor reinforced with a true fruit raspberry flavor, the placing made by experienced judges is not surprising. Placing of this material over number 2 by one point only would suggest that the blend of true fruit materials was a very good one.

The results of this study in Michigan, where the use of pure flavors has been required for several years, show a much greater appreciation of a flavor true to the fruit represented than would be expected. It should be a source of encouragement to manufacturers seeking to manufacture the best possible ice creams.

TREE PLANTING ON CLAY SOILS

By M. W. DAY and T. C. NELSON
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WHILE MOST tree planting is done on the lighter soils, occasionally it is desired to establish plantations on the heavier soils. A planting experiment at the Dunbar Forest Experiment Station has been especially concerned with the species and methods that should be used to establish trees on an Ontonagon clay soil, typical of much of Chippewa County. Areas with these soils usually have many farms without adequate windbreaks.

The site of this experiment was a field of Ontonagon clay which had been under cultivation for a number of years but had been in grass sod for about 10 years. A portion of the field had been planted to spruce a number of years before with poor results. This may be attributed in part to the lack of aeration in the soil and in part to low water availability. This in turn was due to a low absorption rate, deep cracking, retention of light precipitation in the upper soil layer and a high wilting coefficient. Thus a fine-textured, impervious soil is much less suitable for tree growth than is a lighter soil, as has been demonstrated by Stoeckeler and Bates (1).

The area where the experiment was conducted has a high water table during the early growing season. Measurements of the height of the water table during the month of June varied from 4 inches to 2 feet below the ground surface. Such a condition makes planting rather difficult and requires care in the use of equipment to avoid packing or puddling the clay.

The field had a heavy sod ground cover and produced a rank growth of grasses and sedges during the early summer. This vegetation provided serious competition for planted trees and was another factor contributing to poor survival in plantations on these sites.

The problem resolved itself into one of finding species best able to cope with the adverse soil and moisture conditions, and at the

ARTICLE 31-4

same time finding some practical method of ground preparation and planting that might in some degree overcome the handicaps of the site.

To secure adequate aeration, it was first necessary to remove excess surface water by surface drainage ditches. Mound or ridge planting has also been advocated as a means of securing better aeration and drainage (2, 4). Most mound planting is done by European hand methods and is too expensive for use in this country. However, it was felt that some form of ridge was necessary, and an attempt was made to prepare ridges with a tractor, plow and disk harrow, implements available to most planters.

By plowing two or more furrow slices together, a ridge may be formed that will be somewhat higher than the general level of the ground. On clay sod-land it is then usually necessary to go over the

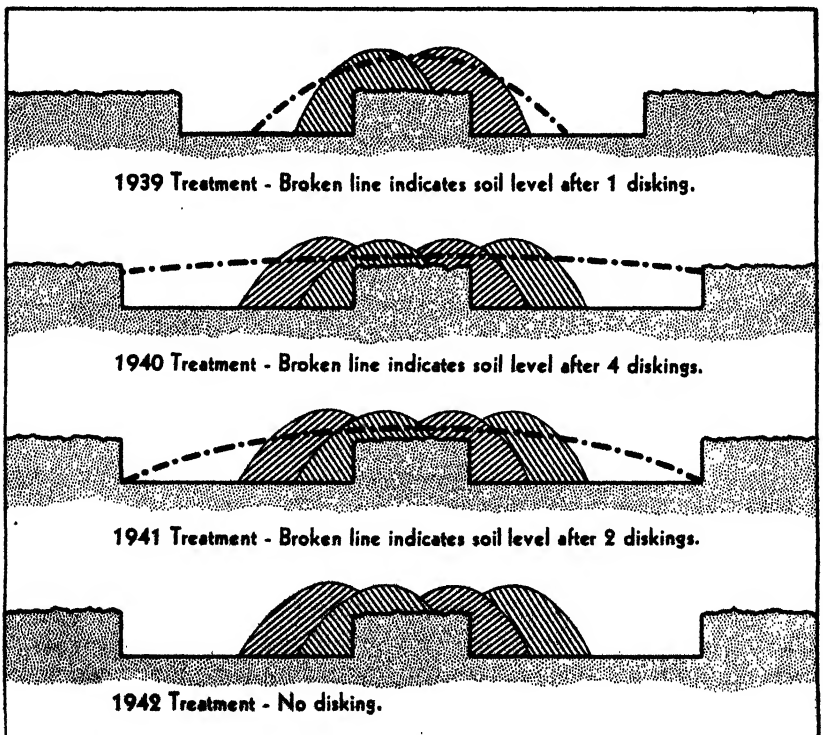

Fig. 1.

ridge at least once to smooth it and reduce air spaces, which cause the soil to dry out prematurely. If planting is delayed long enough to allow the ridge to settle naturally, better planting conditions will result but grass competition will be increased. The methods used during the 4 years are illustrated in Fig. 1, which shows the ridges plowed and after disking. The time of treatment is also indicated.

The 1942 planting was on land that had been kept fallow one season previous to being plowed into ridges. This treatment resulted in the best relief, best planting conditions, and the least vegetative competition during the first growing season.

Since the object of the ground preparation was to increase the soil aeration around the planted trees as well as to reduce the vegetative competition, the 1942 method seemed to accomplish this objective best. Fall plowing, followed by one disking in the spring when soil moisture is such that puddling of the soil will not occur, seems to be the minimum treatment that can be used to obtain good planting conditions and still reduce the vegetative competition sufficiently to allow the trees to establish themselves.

The experiment was carried on in accordance with the plan devised by Wakeley and Chapman (3), except that lack of nursery stock prevented duplicating exactly the same species each year. The area was laid out in a series of randomized blocks designed to insure the reliability of the results obtained.

All planting was by the deep-hole method, using shovels. Each block was planted entirely by a single planter. The date of each planting was chosen for similarity of weather conditions, but some variation was unavoidable here.

RESULTS

The five species used throughout the entire test, white pine *(Pinus strobus)*, red pine *(Pinus resinosa)*, balsam fir *(Abies balsamea)*, green ash *(Fraxinus pennsylvanica* var. *lanceolata)*, and white spruce *(Picea canadensis)* were analyzed as a group. The other species used in the study were compared insofar as possible with the data at hand. All data regarding the studies of survival and vigor have been subjected to analyses of variance, and the conclusions drawn are statistically sound.

As shown in Table 1, the 1939 treatment proved to be less successful than the other three treatments. The soil preparations in the

TABLE 1—*Percentage of trees that survived the first growing season*

Species	Year planted			
	1939	1940	1941	1942
White pine	92	84	95	95
Red pine	98	94	79	97
Balsam fir	31	98	97	91
Green ash	98	99	88	92
White spruce	55	82	99	97

other three years were equally successful so far as initial survival is a criterion. Balsam fir and white spruce had lower survival percentages than the other three species. White pine, red pine, and green ash showed no difference in their survival percentages.

The survival count 5 to 8 years after planting follows trends similar to those observed after the first growing season (Table 2). Although there is no difference between species, both the 1939 and 1940 treatments, the treatments with the least ground preparation, are inferior to the 1941 and 1942 treatments.

Species were graded, according to vigor, in six classes: very thrifty, thrifty, growing, growing poorly, failing, and almost dead. However, in view of the probability that the top three vigor classes would include an increasingly higher percentage of the stand as it matured, the data from the top three vigor classes (very thrifty, thrifty, and growing) were pooled and presented as criteria for the vigor of the plantings. As a safeguard against erroneous conclusions, the data from all the vigor classes were analyzed. The conclusions from these analyses were essentially the same as those formed from the analyses of the top three vigor classes.

Table 3 shows that the species were equal in initial vigor. The 1939 and 1941 treatments were not so successful as the 1940 and 1942 treatments.

TABLE 2—*Percentage of trees that survived to August 1947*

Species	Year planted			
	1939	1940	1941	1942
White pine	71	58	72	70
Red pine	79	47	57	54
Balsam fir	15	80	82	62
Green ash	41	10	60	77
White spruce	48	64	83	84

TABLE 3—*Percentage of total trees planted included in the top three vigor classes at the end of the first growing season*

Species	Year planted			
	1939	1940	1941	1942
White pine	80	77	75	79
Red pine	97	84	30	93
Balsam fir	20	97	82	63
Green ash	90	95	47	83
White spruce	51	73	74	84

The 1939 planting showed very little success with balsam fir. No plausible explanation is offered. The 1941 red pine and green ash indicate reduced vigor. Thirty-seven red pine were classified as "growing poorly" and thus are not included in the tabular presentation of data. A summer frost accounted for the decreased vigor of green ash.

TABLE 4—*Vigor of planting as of August 1947, as expressed in percentage of total trees planted*

Species	Year planted			
	1939	1940	1941	1942
White pine	69	56	71	52
Red pine	74	46	57	52
Balsam fir	13	74	76	57
Green ash	7	1	37	67
White spruce	45	62	83	75

As shown by Table 4, the subsequent vigor of green ash was less than that of other species. No difference was noted between the vigor of the other four species. The 1939 and 1940 plantings were inferior to those of 1941 and 1942.

Scots pine *(Pinus sylvestris)* and jack pine *(Pinus banksiana)* were tested in two year's planting. Although jack pine had a slightly lower survival rate than Scots pine, it proved equal in other respects. Considering both survival and vigor, white pine, red pine, Scots pine and jack pine were equal.

TABLE 5—*Percentage of white and black spruce surviving after first growing season*

Species	Year planted		
	1940	1941	1942
White spruce	82	99	97
Black spruce	83	95	98

A comparison of white spruce with black spruce *(Picea mariana)* showed a high degree of similarity (Table 5).

Norway spruce *(Picea Abies)* was also compared with white spruce in the 1939 treatment and found to be identical in survival and vigor percentages.

Attempts to establish game food species such as elderberry *(Sambucus canadensis)* and mountain ash *(Sorbus americana)* were unsuccessful. All specimens died within a 7-year period. Red-osier dogwood *(Cornus stolonifera)* and northern white cedar *(Thuja occidentalis)* were somewhat better, having a 26-percent and 28-percent survival respectively 7 years after planting. However, these species need further tests before recommendations for them should be given on heavy clay sites.

TABLE 6—*Percentage of hardwood species surviving after 6 years of growth*

Year planted	Basswood	Yellow birch	American elm	Green ash
1941	57	2	84	60

Yellow birch *(Betula lutea)* planted in 1941 proved unsuccessful. Basswood *(Tilia glabra)*, American elm *(Ulmus americana)* and green ash were equally successful (Table 6). White ash *(Fraxinus americana)*, black ash *(Fraxinus nigra)*, and green ash were very similar in survival and vigor in 1939 plantings. However, a frost on July 9, 1947 was less severe on black ash than on white ash and green ash. This accounts for a more vigorous appearance of the black ash. The frost damage to all three species makes their use questionable. Russian olive *(Elaeagnus angustifolia)* plantings were unsuccessful.

Growth was not measured, but a survey of the general appearance of each species indicated that jack pine had made the best growth, followed by Scots pine. The other species were considerably smaller and more uniform in growth, with balsam fir and the other pines all making satisfactory growth. Those hardwoods that were successfully established were growing satisfactorily, but slower than on more protected sites. For windbreak plantings where rate of growth and growth habit must be considered as well as survival, it seems that jack pine, Scots pine, white spruce and black spruce are best adapted to planting on these soils in northern Michigan.

These experimental plantings indicate that reforestation can be

successful on heavy soils if the ground is properly prepared. The 1939 and 1940 plantings, however, proved less successful than those in 1941 and 1942. The essential ground preparation on this soil seems to consist of adequate surface drainage, construction of ridges for the trees to be planted on, and some reduction of the competition from grass and other vegetation.

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OBSERVATIONS ON ROUGH OR "SPOTTY" HOMOGENIZED MILK

By G. M. TROUT *and* J. ROBERT BRUNNER
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RECENTLY, samples of rough or spotty homogenized milk were brought to this laboratory for investigation. This paper reports briefly the results of the study made on these samples and on the processing of the defective milk.

NATURE OF NORMAL HOMOGENIZED MILK

Homogenized milk properly processed and handled is smooth and homogeneous. This characteristic manifests itself in the partially emptied glass or bottle. When some of the milk is poured out, the film left behind on the glass drains so well that the glass appears clean above the milk-surface line. Probably the same capillarity which results in seepage (5) is responsible in part for this superior drainage from the glass surface. Regular users of homogenized milk come to appreciate the clean appearance of the glass in contrast to the greasy film commonly observed on the inner surface of a partially emptied glass of nonhomogenized milk. Consequently, any roughness, spottiness or lack of smoothness within the milk as revealed on the surface of the glass is likely to bring complaints from customers. In such cases, a check on the bottled milk itself may reveal a ring-like film on the surface adjacent to the glass, or may show foam adhering to the bottle closure. This film is dissimilar to that produced by cream which sometimes appears on inadequately homogenized milk, is light in color, lacks smoothness, and seems to be more characteristic of precipitated milk protein.

DESCRIPTION OF THE ROUGH, SPOTTY HOMOGENIZED MILK

Examination of the bottled milk having this defect showed the milk to have a normal viscosity unlike that previously reported (2),

ARTICLE 31-5

Fig. 1. Normal (left) and abnormal (right) films remaining on the inside surface of milk bottles of homogenized milk as the air-space bubble is rotated by tilting the container and turning the bottle slowly. Magnified about two and one-half times.

but a rough, slightly granular foam was found adhering to the under side of the cap. At the milk surface adjacent to the glass was a narrow ring of loose, cream-like material extending out from the glass about one-eighth inch. Upon tilting the closed container, this substance seemed to follow the air-space bubble leaving deposited on the glass tiny specks, as shown in Fig. 1. The specks appeared larger than they actually were, inasmuch as capillarity drew and attached to them some milk. When the milk was poured from a glass, the soiled-glass surface presented a particularly rough, curdy appearance. Children associated this roughness with the milk and in some instances actually refused to drink it.

Further examination of the milk under a stereoscopic microscope with 42.5× magnification showed the presence of many semi-translucent spherical pellets. These pellets varied in size, the larger ones being barely macroscopic. Intermixed was considerable solid material, amorphous in character, thought to be chiefly protein which probably resulted from collapsed air-cell walls, since the defect was associated more or less with foaming. By means of a needle the spherical pellets could be moved intact from the liquid surrounding them to the dry area of the glass slide, where they could be studied separately. Here they appeared gelatinous and sticky and spread under pressure, offering little resistance. After some exposure to heat, the serum surrounding the pellets dried, and the pellets them-

selves flattened as the semi-solid material changed into a translucent liquid. The oily liquid readily took the fat-soluble dye, Sudan III. All observations indicated that the tapioca-like pellets causing the trouble were fatty in nature. However, fat tests from top and bottom portions of the sample showed the milk to be well homogenized. In fact, in analyzing homogenized milk exhibiting considerable fat rising, the writers had never before encountered such a defect as that reported herein. The pellets were well out of the microscopic micron size of fat globules and approached the macroscopic granule size.

INVESTIGATION OF THE CAUSE OF THE DEFECT

Sequence of Processing

The sequence of processing the defective milk consisted of clarifying, preheating, homogenizing, high-temperature short-time pasteurizing, cooling, and bottling. The processing system was essentially a closed system except (a) during homogenization, when the milk was conducted from the preheating section of the pasteurizer to an open surge tank from which it entered the homogenizer, and (b) in the surge tank ahead of the bottlers. Considerable foam gathered at the surface of the milk in the surge tanks. However, a sufficient head of milk was maintained so the macroscopic foam could not be occluded in the milk. Nevertheless, there was a possibility that some air might have been homogenized into the milk giving rise to a microscopic foam. From the pasteurized milk surge tanks to the bottlers was a distance of approximately 15 feet and a drop of about 6 feet. Two fillers, a vacuum and a gravity-flow, were used. Some difficulty was encountered with foam in filling the bottles by either machine, but the rough, spotty defect appeared worse in the milk filled with the vacuum filler.

Routine Microscopic Examination of the Milk at Various Steps of Processing

Inasmuch as the gelatinous, tapioca-like pellets were always observed in the rough-appearing homogenized milk and seemed to be foreign to that product, inquiries were made to ascertain whether a stabilizer or any other foreign substance might have been added. Such was not the case. A detailed routine microscopic examination

TABLE 1—*Examination of milk at various stages of processing*

Nature and source of sample	Presence of pellets in the sample*
Raw, holding tanks	−
Raw, beyond clarifier	−
Raw, preheated	−
Raw foam, surge tank ahead of homogenizer	−
Preheated, homogenized	−
High-temperature short-time pasteurized	−
Pasteurized, cooled	−
Foam on pasteurized milk surge tank	−
Milk at entrance to filter reservoir	−
Bottled milk	−
Vacuum filler	+
Gravity filler	+

*Key −No pellets present.
+Pellets present.

was made of the milk at various steps of processing. The results are shown in the accompanying table.

From the data in Table 1 it should be noted that the pellets causing the difficulty were not observed during the various stages of processing until the milk reached the filling machines. Examination of the milk in the filling machines showed the presence of a rough, granular, swirling foam, portions of which evidently were being entrapped with the incoming milk and hence carried into the bottles. This foam was heavily seeded with the pellets in question.

Realizing that properly homogenized milk cannot be churned except by prolonged rigorous agitation and then only in part, an investigation was begun to ascertain how the pellets came to exist in the filler reservoirs. Evidence pointed to the fact that nonhomogenized fat had been introduced into the reservoirs prior to bottling the homogenized milk. Upon questioning the operator at the bottle-filling machines, it was learned that prior to bottling homogenized milk, whipping cream, table cream and half-and-half were bottled. No attempt was made to rinse out the bottle-filling machines between filling operations. Examination of the whipping cream, table cream and half-and-half revealed the presence of the tapioca-like, fatty pellets characterizing the defective milk. A complete dismantling of pipes and a thorough clean-up after bottling the nonhomogenized products eliminated the cause of the rough or spotty texture of the homogenized milk.

DISCUSSION

Too much emphasis cannot be placed on the necessity of having properly homogenized milk free from contamination with a non-homogenized product if the bottled product is to remain smooth and free from a cream layer of fatty particles. Likewise, foaming must be kept to a minimum, for it may result in partially filled bottles (4) and in a concentration of milk solids resulting from the presence of denatured proteins. Because solid materials migrate to the foam film, more solids exist in the foam than in the liquid from which the foam was derived. Consequently, the collapse of these air cells results in a flaky concentration of denatured milk solids at the surface. Presumably, this is the "Ramsden phenomenon" (3) as suggested by Davies (1).

Much experience has been gained during the last score of years in processing and handling homogenized milk. It seems, however, that the necessity for special precautions in treating homogenized milk is not yet fully appreciated.

SUMMARY

An instance of a rough, spotty homogenized milk causing consumer complaints was found to be due chiefly to the presence of tiny spherical butterfat granules coming from creams bottled prior to bottling of the homogenized milk without cleaning the equipment. The defect was attributable in part to foaming.

Dismantling and cleaning the equipment after bottling the non-homogenized product eliminated the condition causing the defect.

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TIME STUDY OF SMALL SAWMILL AIR DOGS

By J. W. CREIGHTON

SECTION OF FORESTRY OF THE MICHIGAN AGRICULTURAL EXPERIMENT STATION AND THE LAKE STATES FOREST EXPERIMENT STATION OF THE U. S. FOREST SERVICE COOPERATING

IN FEBRUARY 1947, a report, "Air Dogs for Small Sawmills," was published in the *Michigan Agricultural Experiment Station Quarterly Bulletin,* and in September 1947, blueprints of the air dogs were made available. Considerable interest in these air dogs was aroused, but there was some question in the minds of sawmill operators as to the value of the dogs to their particular operations. It is the purpose of this report to indicate what value the dogs have in the L. L. Johnson Lumber Co. sawmill at Charlotte, Michigan, where they have been in continuous operation over a period of time. The basis of the report is a time study of a sample of 498 logs, half of which were sawed using only hand dogs and the other half using air dogs. This sample and the conditions under which it was sawed may be assumed to be reasonably representative of the milling operation at this sawmill. The results, therefore, could be applied to a yearly operation with an expectation of reasonable accuracy.

It does not necessarily follow that the savings effected in the L. L. Johnson sawmill will be duplicated in other mills. Work habits within different mills and with different sawyers and block setters are so variable that it is impossible to apply the results of a time study in one mill to another even though the same class of equipment is used and the same number of men is employed. Also, grades of logs and quality of lumber cut from the same log grades vary so widely that the monetary value to a sawmill of the air dogs can be appraised only by arriving at the monetary value of a sawing minute for that particular mill and applying it to the time saved. The results at the Johnson mill can, therefore, be used only to estimate possible savings in other operations.

ARTICLE 31-6

DESCRIPTION OF OPERATION

The Johnson sawmill is a 6-foot band mill with a three-headlock carriage driven by a twin-engine steam feed. The crew consists of a combination pond and deck man, a block setter who rides the carriage alone, a sawyer, an off-bearer, and others to edge, trim, and handle lumber. However, only the block setter and sawyer directly affect the operation insofar as the time study is concerned. Logs are hauled into the mill from the log pond by the jack chain and rolled off the chain to the log deck by a bull chain. The log deck is only slightly sloped, as there is no stop and loader, so logs must be rolled down the deck by the deck man. The mill is equipped with a friction nigger to turn logs.

Sawing at the mill is for grade as much as possible, and all logs with the exception of an occasional extremely crooked or knotty one are sawed as shown in Fig. 1.

Obviously the air dogs would affect the time consumed only during the loading, unloading or turning of the log. These operations were, therefore, broken down into the following elements: Undogging, turning and taper setting, dogging, reaching position to set,

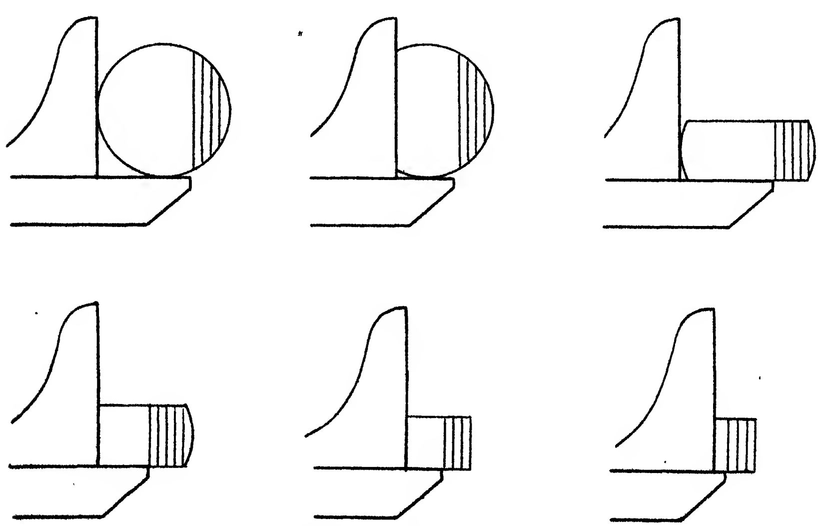

Fig. 1. Log positions.

TIMING POINT	ABBREVIATION	EXPLANATION
Undog	U	Time of first motion to undog logs.
Undog completed	UC	Time log is free of dogs and can be turned.
Dog	D	Time of first motion to dog.
Dogging completed	DC	Time dogs are set and block setter is free for his next operation.
Set	S	Time of first motion to set log for sawing.
Set completed	SC	Time log is in position on carriage for cutting. In most cases this is the time at which the sawyer signals the block setter to stop setting.
First saw cut	C	Time saw first touches log for each new log position.

Fig. 2. Element timing points.

setting, and feeding to cut. Timing points bounding these elements are shown in Fig. 2.

In making the study, times for each log were recorded on separate forms (Fig. 3). Time figures were placed above the dotted line for each timing point, leaving room for the difference between the points or the element time below the dotted line. The difference between U and UC is the undogging time, the difference between UC and D is the turning time, between D and DC the dogging time, between DC and S the time to reach position to set, between S and SC the setting time, and between SC and C the feed to cut time. Where no dogging time was consumed in the turning operation, the difference between UC and S would then be the turning time. A minute decimal watch was used giving time in minutes and hundredths of a minute. For ease of recording, the watch was brought back to zero before each turn.

In loading the logs there is no undogging operation, so the first series of times starts with the first motion to dog. Normally each timing point must be recorded for the turn to the second log position. It will be noted that in only these two operations is any time charged against the block setters reaching position to set. This is typical of all logs dogged pneumatically because in these two positions the block setter must step forward on the carriage to hold the log against

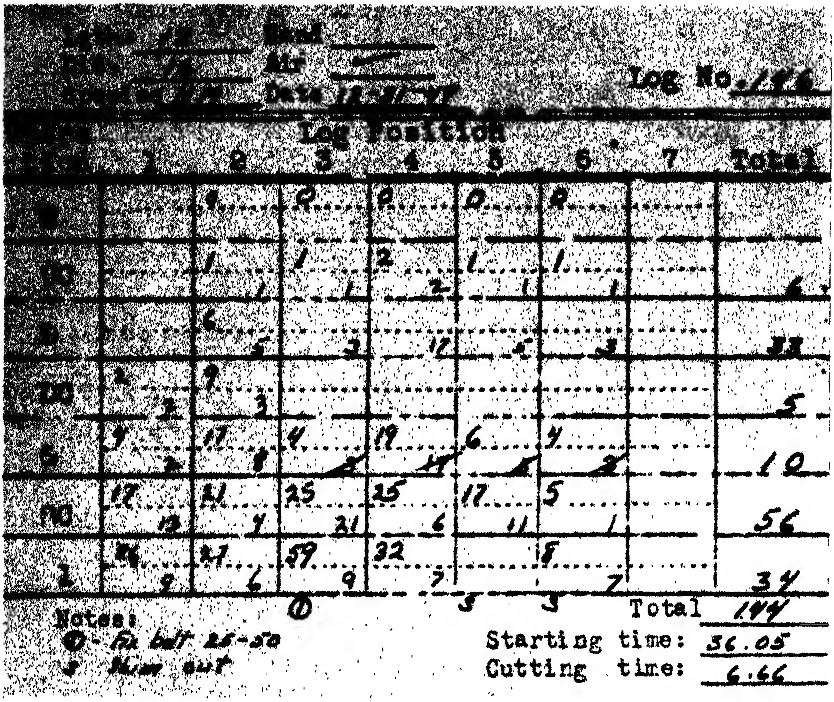

Fig. 3. Element time data form.

the knees for dogging. In log positions where there is a flat face down, the block setter need not leave his position and therefore is ready to set at any time.

It will be noted that, starting with the third position, no time is recorded for dogging. This does not mean that the log is not dogged in these positions but that dogging is accomplished during another operation so no time can be charged against it. Usually the air dogs are set during the motion of the carriage to the cut or while the saw is actually cutting. This cannot, of course, be done with the hand dogs for safety reasons so time must be charged against each hand dogging operation. In any position in which no dogging time is taken, lower S would then be the turning time. As is shown in Fig. 3, this time was crossed off and elevated to line D for ease of computing total turning time.

The dogging procedures are somewhat different when hand dogs

are used. Since the block setter must step forward on the carriage to undog, he waits there for the log to be turned before returning to setting position. Time is, therefore, chargeable to both dogging and the return to setting position except in the infrequent instances when these elements of the operation can be performed on free time produced by the sawyer.

After logs have been squared, the first cut in the new log position for both the hand and air operations is very often a shim cut to straighten out crook in the cant. For the shim cuts, the sawyer does not wait for the log to be set but feeds the log up to the saw during the setting operation. The setting proceeds until the time the log touches the side of the saw, so no time is charged against feeding to cut. For some positions no initial setting is required, so all the time was charged against the feed of the carriage up to the saw.

COMPUTATION

Data forms were first sorted by species, diameter and length. A comparison after sorting showed that, as one would expect, the average total sawing time, per log, varied according to species, length, and diameter. However, only the time of saw and gig back varies between length classes and between species for a given diameter, and the time to undog, turn, dog, set, and feed to cut remains constant. Since only these element times are affected by the air dogs, and since they remain constant for any given diameter provided the same dogs are used, it is unnecessary for purposes of this study to break down each diameter by species and length. If there were a wide discrepancy between the number of logs in each species and length sawed using hand dogs and those sawed using air dogs it would be re-

TABLE 1—*Number of logs by species*

Species	Operation		Total	Percentage of total
	Hand	Air		
Hard maple	111	116	227	45.6
Beech	53	50	103	20.7
American elm	42	40	82	16.5
Basswood	22	20	42	8.4
Soft maple	18	21	39	7.8
White ash	3	2	5	1.0
Total	249	249	498	100.0

TABLE 2—*Number of logs by lengths*

Length in feet	Operation		Total	Percentage of total
	Hand	Air		
8	2	3	5	1.0
10	35	38	73	14.7
12	97	102	199	40.0
14	70	67	137	27.5
16	45	39	84	16.8
Total	249	249	498	100.0

flected in the saw and gig-back time only and therefore would not affect the comparison between the two types of dogs. Distribution of logs by species and length is shown in tables 1 and 2.

To compute the results, the element times for each log position were obtained by subtracting the time at the first timing point from the time at the last timing point bounding that element. Element times for each log position were then added horizontally, as illustrated in Fig. 3, to arrive at the total time consumed for the log for each element of the operation. Total sawing time for each log was then found by subtracting the starting time for that log from the starting time for the succeeding log. The base sawing time, which includes the saw and gig-back time exclusive of turn, undog, dog, set and

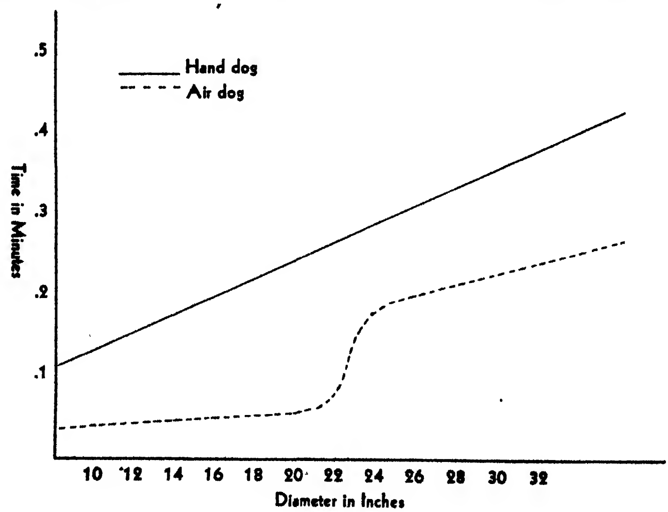

Fig. 4. Undogging time.

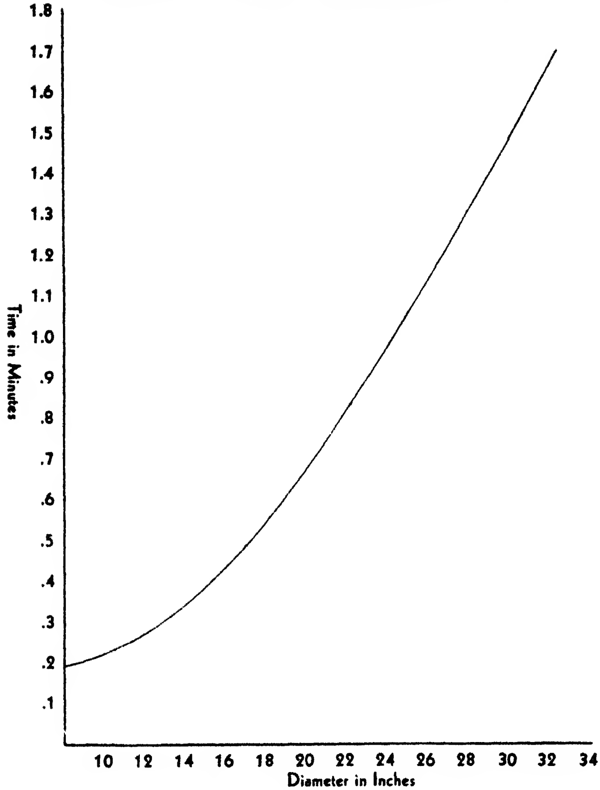

Fig. 5. Turning time.

feed to cut, is the difference between the total sawing time and the sum of the element times for each log.

Cards were then sorted by diameters and the average time computed for each element in each diameter. These are shown in Table 3. The average times were then plotted on coordinate paper, Figs. 4, 5, 6, 7, 8, 9 and 10, and the corrected element times and corrected base sawing times taken from the resulting curves. The air dogs open only to 23 inches so large logs must be held for initial cuts by hand dogs. This accounts for the jump in air dog time curves in Figs. 4 and 6. Table 4 shows the corrected element times and the total of all elements for both the hand and air dog operations for each diameter. In Table 5 the total element time and the base sawing time are added, giving the total sawing time per log for both the hand and air dog operations for each diameter. Multiplying by the number

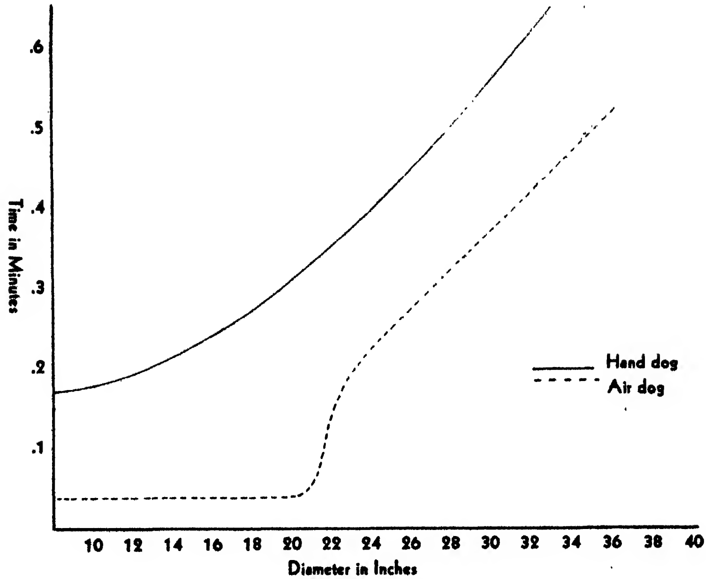

Fig. 6. Dogging time.

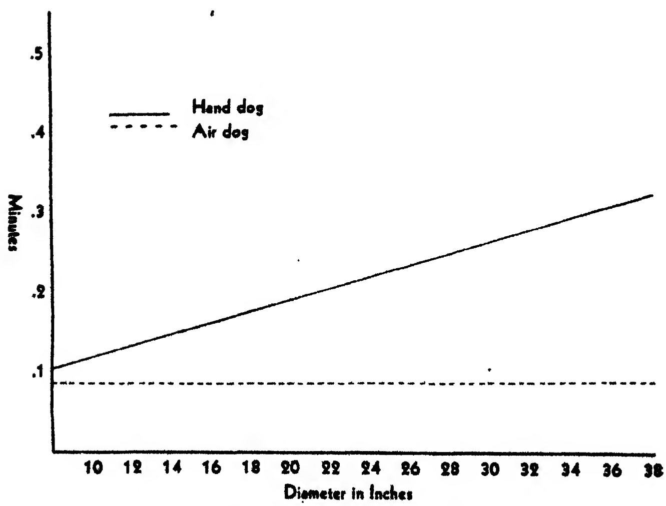

Fig. 7. Time to reach position to set.

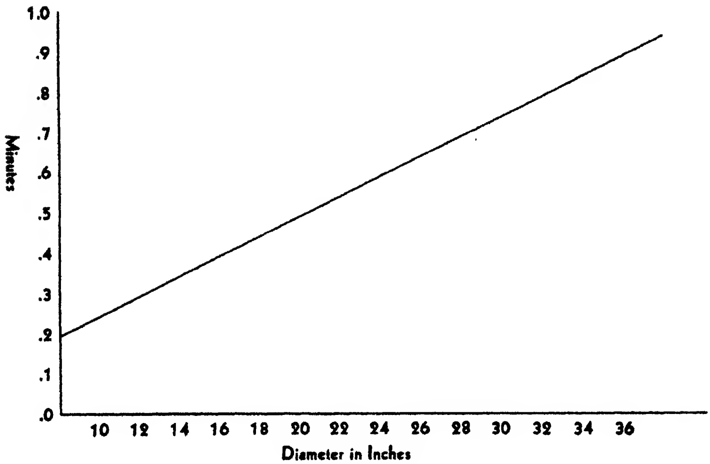

Fig. 8. Setting time.

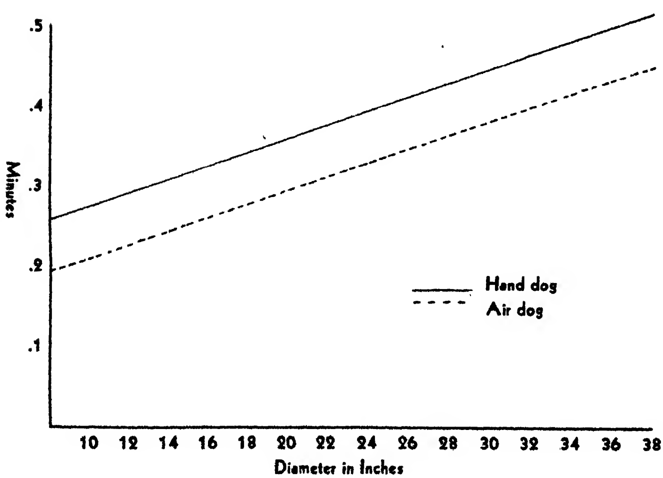

Fig. 9. Feed to cut time.

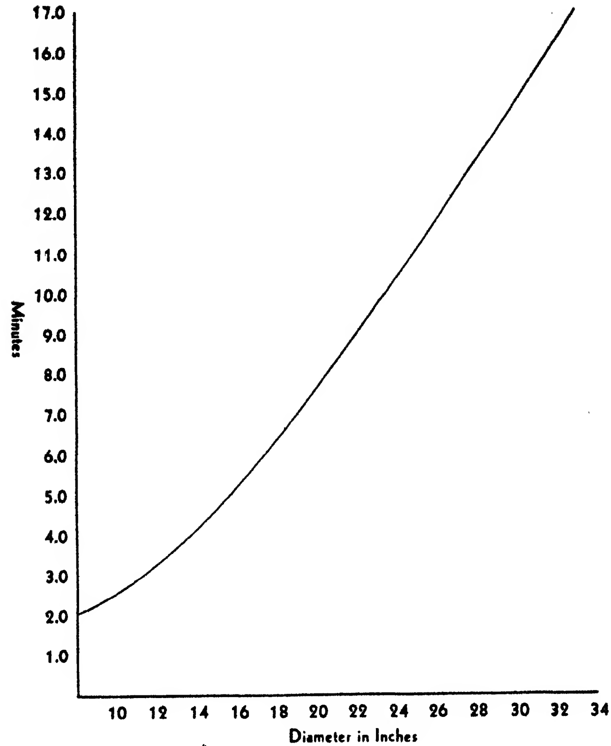

Fig. 10. Sawing time.

of logs in the diameter class gives the total sawing time which would be consumed by that diameter class in the 498-log sample for the hand dog and air dog operations. The difference between the total times is then the time saved by the air dogs for logs in that diameter.

From Table 5 it may be seen that the total sawing time for the 498 logs using hand dogs would be 3,651 minutes and the time saved would be 236.092 minutes if air dogs had been used. The percentage of saving of the the actual sawing time would then be expressed by the following formula:

$$= \frac{\text{Hand dog time} - \text{air dog time}}{\text{hand dog time}} \times 100 = \text{percentage of saving}$$

$$\frac{236.092}{3{,}651} = 6.46\%$$

TABLE 3—*Average element times in minutes by diameters*

Diameter	Number of logs		Undogging		Turning		Dogging		Position to set		Setting		Feed to cut		Sawing and gig-back all logs
	A	H	A	H	A	H	A	H	A	H	A	H	A	H	
9..........	7	7	.039	.125	.200	.210	.039	.175	.075	.120	.210	.215	.200	.275	2.31
10..........	8	12	.040	.139	.230	.230	.040	.190	.090	.115	.249	.240	.215	.275	2.58
11..........	12	12	.040	.132	.265	.250	.038	.170	.090	.130	.250	.285	.215	.290	2.91
12..........	20	16	.043	.172	.276	.260	.041	.200	.072	.130	.280	.294	.230	.290	3.28
13..........	23	21	.044	.170	.300	.355	.041	.220	.092	.135	.320	.330	.245	.300	3.75
14..........	25	25	.048	.170	.340	.338	.039	.205	.085	.160	.360	.302	.225	.308	4.21
15..........	27	27	.047	.189	.400	.390	.038	.228	.085	.142	.355	.365	.258	.320	4.76
16..........	29	27	.050	.200	.490	.400	.040	.240	.094	.171	.400	.380	.260	.327	5.03
17..........	24	25	.052	.220	.500	.480	.043	.256	.078	.163	.380	.412	.270	.340	5.96
18..........	18	20	.054	.240	.490	.600	.040	.287	.100	.80	.451	.440	.280	.330	6.45
19..........	12	12	.059	.230	.580	.640	.041	.285	.074	.185	.460	.510	.288	.351	7.01
20..........	11	10	.059	.243	.722	.700	.042	.305	.105	.190	.500	.486	.284	.350	7.62
21..........	9	7	.063	.244	.780	.735	.062	.340	.082	.210	.534	.512	.310	.367	8.36
22..........	7	8	.089	.268	.830	.840	.151	.355	.080	.196	.534	.530	.275	.382	8.93
23..........	5	6	.160	.285	.862	.950	.200	.410	.090	.205	.571	.580	.308	.380	9.77
24..........	4	3	.187	.250	.960	.980	.230	.395	.102	.225	.640	.580	.345	.380	10.40
25..........	5	4	.196	.290	1.130	.990	.247	.426	.080	.225	.610	.654	.330	.413	11.10
26..........	2	2	.205	.350	1.350	1.220	.280	.420	.095	.230	.630	.740	.355	.400	11.80
27..........	1	2	.210	.275	1.300	1.180	.300	.500	.080	.245	.670	.660	.340	.410	12.72
28..........	—	1	—	.300	—	1.280	—	.500	—	.240	—	.690	—	.450	13.27
29..........	1	1	.230	.370	1.360	1.400	.320	.560	.090	.230	.690	.770	.370	.410	14.00
30..........	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31..........	—	1	—	.370	—	1.520	—	.550	—	.270	—	.820	.410	.470	15.40
32..........	1	1	.240	.400	1.840	1.550	.430	.620	.090	.280	.780	.740	.390	.450	16.92

TABLE 4—*Corrected element times in minutes taken from Figs. 4, 5, 6, 7, 8, 9*

Diameter	Undogging		Turning	Dogging		Position to set		Setting	Feed to cut		Total		Saving per log	Percent saved
	H	A		H	A	H	A		H	A	H	A		
9	.123	.038	.205	.172	.038	.111	.086	.218	.265	.200	1.094	.785	.309	28.2
10	.134	.040	.224	.177	.038	.118	.086	.242	.274	.209	1.169	.839	.330	28.2
11	.145	.042	.246	.183	.038	.125	.086	.267	.283	.217	1.249	.896	.353	28.3
12	.157	.044	.273	.191	.038	.132	.086	.290	.291	.225	1.334	.956	.374	28.3
13	.168	.046	.306	.201	.038	.140	.086	.316	.300	.235	1.431	1.027	.404	28.2
14	.178	.047	.345	.213	.035	.147	.086	.340	.308	.243	1.531	1.099	.432	28.2
15	.189	.049	.390	.226	.038	.154	.086	.364	.317	.252	1.640	1.179	.461	28.1
16	.200	.050	.440	.240	.038	.161	.086	.389	.325	.260	1.755	1.263	.492	28.0
17	.212	.052	.492	.255	.038	.168	.086	.414	.333	.269	1.874	1.350	.524	28.0
18	.223	.053	.552	.272	.038	.176	.086	.439	.342	.277	2.004	1.445	.559	27.9
19	.234	.055	.614	.289	.038	.183	.086	.464	.350	.286	2.134	1.543	.591	27.7
20	.245	.058	.680	.309	.040	.190	.086	.489	.358	.295	2.271	1.648	.623	27.4
21	.257	.064	.750	.330	.060	.197	.086	.515	.368	.303	2.417	1.779	.639	26.4
22	.268	.090	.824	.352	.153	.204	.086	.540	.337	.312	2.565	2.005	.560	21.8
23	.279	.158	.900	.375	.197	.212	.086	.565	.385	.321	2.716	2.227	.489	18.0
24	.290	.85	.981	.398	.226	.219	.086	.590	.394	.329	2.872	2.397	.475	16.5
25	.302	.195	1.070	.423	.252	.226	.086	.615	.402	.338	3.038	2.556	.482	15.9
26	.313	.202	1.143	.449	.276	.233	.086	.640	.410	.346	3.188	2.693	.495	15.5
27	.324	.209	1.228	.475	.300	.240	.086	.665	.419	.355	3.351	2.843	.508	15.2
28	.336	.216	1.315	.504	.325	.247	.086	.690	.427	.363	3.519	2.995	.524	14.9
29	.347	.222	1.403	.532	.350	.254	.086	.713	.437	.372	3.686	3.146	.540	14.7
30	.358	.228	1.495	.561	.374	.262	.086	.738	.445	.380	3.859	3.301	.558	14.5
31	.369	.234	1.584	.590	.397	.269	.086	.761	.453	.388	3.026	3.450	.576	14.3
32	.380	.242	1.680	.622	.422	.276	.086	.783	.462	.397	4.203	3.610	.593	14.1

TABLE 5—*Total sawing time in minutes for hand and air dog operations*

Diameter	No. of logs	Base sawing time, Fig. 10	Total from table 4		Total sawing time per log		Total sawing time for sample by log diameter		Time saved Cols. 8–9
			Hand	Air	Hand c. 3–4	Air c. 3–5	Hand c. 2x6	Air c. 2x7	
1	2	3	4	5	6	7	8	9	10
9.....	14	2.30	1.094	.785	3.394	3.085	47.516	43.190	4.326
10.....	20	2.59	1.169	.839	3.759	3.429	75.180	68.580	6.600
11.....	24	2.91	1.249	.896	4.159	3.086	99.816	91.344	8.472
12.....	36	3.31	1.334	.956	4.644	4.266	167.184	153.576	13.608
13.....	44	3.73	1.431	1.027	5.161	4.757	227.084	209.308	17.776
14.....	48	4.20	1.531	1.099	5.731	5.299	275.088	254.352	20.736
15.....	54	4.70	1.640	1.179	6.340	5.879	342.360	317.466	24.894
16.....	56	5.24	1.755	1.263	6.995	6.503	391.720	364.168	27.552
17.....	49	5.80	1.874	1.350	7.674	7.150	376.026	350.350	25.676
18.....	38	6.39	2.004	1.445	8.394	7.835	318.972	297.730	21.242
19.....	24	7.00	2.134	1.543	9.134	8.543	219.216	205.032	14.184
20.....	21	7.66	2.271	1.648	9.931	9.308	208.551	195.468	13.083
21.....	16	8.33	2.417	1.778	10.747	10.108	171.952	161.728	10.224
22.....	15	9.01	2.565	2.005	11.575	11.015	173.625	165.225	8.400
23.....	11	9.71	2.716	2.227	12.426	11.937	136.686	131.307	5.379
24.....	7	10.40	2.872	2.397	13.272	12.797	92.904	89.579	3.325
25.....	9	11.10	3.038	2.556	14.138	13.656	127.242	122.904	4.338
26.....	4	11.81	3.188	2.693	14.998	14.503	59.992	58.012	1.980
27.....	3	12.56	3.351	2.843	15.911	15.403	47.733	46.209	1.524
28.....	1	13.33	3.519	2.995	16.849	16.325	16.849	16.325	.524
29.....	2	14.06	3.686	3.146	17.746	17.206	35.492	34.412	1.080
30.....	—	14.78	3.859	3.301	18.639	18.081	—	—	—
31.....	1	15.57	4.026	3.450	19.596	19.020	19.596	19.020	.576
32.....	1	16.35	4.203	3.610	20.553	19.960	20.553	19.960	.593
	498						3,651.337	3,415.245	236.092

SAVINGS EFFECTED BY AIR DOGS

The L. L. Johnson Lumber Company normally operates 8 hours or 480 minutes a day. Of this, an average of 37.5 minutes are consumed by saw changing, repairs and other non-productive activities, leaving a total of 442.5 minutes a day toward which the saving would apply. The saving in sawing time would then be 442½ minutes × .0646 or 28½ minutes per day.

The mill averages approximately 8,000 feet per operating day. The operators value the time of the sawing minute at not less than 50 cents, although there is good reason to believe it is actually higher than this. When the 50-cent value is applied against the time saved, it may be seen that the saving per operating day is approximately $14.25.

Following is a breakdown of costs of the two-dog assembly.

1.	Air compressor, 9 cubic feet	$227.00
2.	Pressure tank with gage, 10-gallon	20.58
3.	Speed-control valve	5.62
4.	Reducing valve, lubricator, and air cleaner, (Logan assembly)	38.50
5.	2 air cylinders, 3-inch bore, 19-inch stroke, at $40.50	81.00
6.	2 air cylinders, 4-inch bore, 8-inch stroke, at $38.50	77.00
7.	2 valves, Logan, three-way, at $12.00 each	24.00
8.	Air hose, pipe, and fittings	25.00
9.	Steel	22.50
10.	Labor	150.00
	Total	$671.21

The air compressor used to provide air pressure is belted directly to a line shaft which drives the main saw mill; no extra motor need be provided to drive it. Power cost, therefore, is a negligible factor for this particular operation. The only operating costs which need be considered are the cost of alcohol to prevent the lines from freezing, the cost of lubricating oil which is injected into the air lines, and the depreciation of the equipment. Assuming that the equipment will be fully depreciated in 5 years, the total operating expense would be approximately 75 cents per day. The increase in net income would then be: $14.25 — .75 or $13.50 per day.

APPLICATION TO OTHER MILLS

It is impossible to predict accurately the savings which might be effected in other mills by installation of the air dogs without time studies to determine present operating times. However, the results at the L. L. Johnson sawmill may be used to estimate savings.

For purposes of comparing time savings, small sawmills will fall into one of the four following classifications:

1. Mills in which there is one carriage rider, the block setter, who does all the dogging and setting.

2. Mills with a block setter, who also operates the front dog, and a tail dogger to operate the rear dogs.

3. Mills with block setter and tail dogger in which logs are turned by an overhead turner and the tail dogger must step off the carriage to set the turning chain.

4. Mills with no carriage rider in which the sawyer sets the dogs.

The Johnson sawmill is in the first group. Before the air dogs were installed, there was only one carriage rider and normally he set only one dog in a log. Other mills operating in this manner could expect time savings approximately equal to those at the Johnson mill, provided the average daily cut was approximately the same. If the block setter customarily uses more than one dog the saving would be even greater.

In mills of the second group, the block setter usually does the same work as the block setter in the first group. He sets blocks and operates the front dog. He is assisted on the carriage by the tail dogger who operates the tail dogs. If the air dogs were installed, the block setter would be able to set all dogs with less lost time than he now uses to set one dog. Savings in time would be approximately equal to those in group one, and there would be the further saving of the elimination of one man, the tail dogger.

Mills of the third group would save approximately the same amount as the first. The tail dogger can be eliminated from the carriage but he must still be kept to handle the turning chain. There is a possibility with some setups that the work with the turning chain and the log deck work can be combined for further saving.

Mills in the fourth group would be able to save only in time. The dogging operation could be done just as quickly with air dogs as in any of the other mill groups, for the sawyer would be able to control the dogs with two small levers placed within easy reaching distance. The percentage of time saved by an installation of the air dogs would be greater in this than in any other type of mill. However, since these mills are usually small and do not produce as much as larger ones, the value saving would possibly not be as great as in the other three groups.

IMPROVED WORKING CONDITIONS

Owners of the Johnson sawmill feel that the improvement in working conditions is no less valuable than the time saved. With the air dogs in operation, the block setter need climb over the carriage very

little and he never need move on the carriage when he is near the saw. Except when he must set for taper or hold a log against the knees for dogging he can do all his work from one position.

A study of time taken at different periods of the day indicates that no time saving is effected through reduction of fatigue to the block setter. However, the reduction of fatigue is of value to the mill owners because most accidents happen to tired men.

The air dogs also tend to increase the working life of the block setter. Climbing over the carriage is hard for older men, and if they can do their work from one position on the carriage they will not tire so quickly.

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WOOD PRODUCTION ON THE DUNBAR FOREST EXPERIMENT STATION

*By P. W. ROBBINS**
SECTION OF FORESTRY

THE DUNBAR Forest Experiment Station lands are located on the north end of Neebish Island and on the west bank of the St. Mary's River opposite Neebish Island, at the junction of the Charlotte and St. Mary's rivers, 16 miles southeast of Sault Ste. Marie, Michigan.

The first record of a timber sale was made while the property was still in private ownership. Cuttings were made during the winter of 1903 and 1904 for cordwood, and were sold to a dredging company operating on the St. Mary's River. Logging operations in the Dunbar Station area between 1890 and 1925 removed the scattering of white pine and hemlock and the best stands of pulpwood.

While the land was owned by the Dunbar County Agricultural School from 1911 to 1925, only wood was used for fuel. Many hundreds of cords of fuelwood were removed during this period. Since 1925, when the property was taken over by the Forestry Department of the College, all cutting operations have been recorded. This report covers only the original Dunbar Station lands, and does not cover the lands acquired since 1939.

A summary of the cutting operations on the forested area for the period 1926 through 1946 follows:

Cedar fence posts	241
Christmas trees	3,704
Cords of stove wood (16-inch)	977
Standard cords fuelwood	455
Standard cords pulpwood	716
Cubic feet, cabin logs and piling	29,475
Board feet of veneer and saw logs	179,202

*Director, Dunbar Forest Experiment Station 1927 to 1936.

ARTICLE 31-7

This represents a cut of approximately 30 percent of the original volume of the forest. Yet the forest is in better condition and growing more rapidly today than it was in 1926.

To illustrate in three areas: The first selection cutting operation in 1926 from one compartment removed 35 standard cords of fuelwood and 11 cords of pulpwood. The fuelwood was consumed at the Station and the pulpwood banked and sold at the mouth of the Charlotte River to the pulp barge operating on the St. Mary's River. In 1927, 55 cords of hardwood were removed in an improvement cutting from another compartment. In 1928, 9 cords of hardwood were removed in an improvement cut in still another compartment, and in 1929, 48 cords of balsam fir and white pine pulp, 8 cords of spruce pulp, 48 cords of hardwood fuel and 700 board feet of hardwood logs were removed during the next improvement cut in the same compartment.

In 1932 and 1933 there were many unemployed persons in Sault Ste. Marie, and to help them and to benefit the forest by an improvement cutting, each person was allowed to cut 4 standard cords of hardwood from trees marked in a 29-acre compartment. Chippewa County transported the men and hauled their wood. In 1930, cutting operations were confined to two experimental plots, one in a spruce-fir-white pine area and one in a red maple-yellow birch-balsam fir area.

When the Station was first acquired, there was no outlet for the sale of saw logs as truck transportation of logs had not been developed in the area. There was a ready market for pulpwood banked on the Charlotte or St. Mary's rivers. Therefore, the cutting plans called for development of the conifer stands and conversion of the low-quality hardwood areas to conifer production.

In 1934 and 1935, with the aid of the Civilian Conservation Corps, much of the aspen and balsam poplar were girdled, where they were suppressing conifers. This girdling project aided the conifers and resulted in a marked increase in their growth.

An area purchased in 1929, from which a local jobber had removed all the merchantable pulp and excelsior wood in 1924, had a good stocking from seedlings established before and after the cutting occurred.

In 1927 a study (1) of the reproduction on the area led to the conclusions that the spruce and balsam fir would fully restock the

area. In 1934 the Civilian Conservation Corps made a thinning and release cutting on this area and removed 33,000 spruce and balsam fir, which left the area with approximately 1,200 conifers an acre spaced 3 to 4 feet apart. The aspen on the area were cut, lopped, and scattered wherever they were suppressing conifers. At the rate this plot is growing, the area will be ready for a second harvest cutting in 30 years or less after the clear cutting of 1924.

Another area purchased in 1932 had been clear cut during the first World War and also had all the merchantable pulpwood removed. Dunbar Station conducted an improvement cutting in this area in 1935 which resulted in rapid growth and development of the spruce and balsam fir. Today, this area is being cut and is producing a heavy volume of pulpwood per acre just 28 years after the first clear cutting.

In 1929 an experimental cutting plot was established on an area which had a total merchantable volume of 22.5 standard cords an acre composed of balsam fir, 41 percent; white spruce, 29 percent; white pine, 6 percent; aspen, 13 percent; and all other species, 11 percent. The cutting removed 59.5 percent of the total merchantable volume. This included all balsam fir down to merchantable size, the spruce down to 10 inches (D.B.H.), and all aspen, birch and maple. On the basis of the growth records so far recorded on this plot, the area will have regained its original volume by the end of 20 years (3).

On the basis of the cutting operations over the entire Dunbar Forest Experiment Station which have removed approximately 30 percent of the original volume, and which have left the forest in better condition and growing more rapidly today than in 1926, and the detailed records from the experimental cutting plots, and the old clear-cut areas, plus Bowman's (1) conclusions that the recovery of cut-over spruce-fir pulpwood lands depends on the nucleus of spruce and fir left after logging, it may be concluded that:

1. The selection method of cutting is adaptable to the spruce-balsam fir type provided a sufficient volume of growing stock of desirable pulpwood species are left.

2. Selection cutting offers protection from windthrow if the degree of cutting is not over 50 to 60 percent and especially if the white pine in the stand is retained for sawlogs in the second cut.

3. Clear-cut areas of pulpwood types will produce a second crop in approximately 28 to 30 years, when they have adequate reproduction on the ground or establish it immediately following logging operations and receive improvement cuttings during the rotation.

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TOTAL AND DIFFERENTIAL LEUCOCYTE VALUES OF BLOOD FROM ALBINO RATS OF THE WISTAR STRAIN

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SECTION OF FOODS AND NUTRITION

CONCENTRATIONS of the formed elements of the blood are criteria often used in judging the effect of diets. The establishment of average values for each species is necessary for the interpretation of experimental findings. That significant differences in total and differential leucocyte counts of the strains within a species exist has been pointed out by Reich and Dunning (4) in their comprehensive study of the bloods of laboratory rats. They did not study the Wistar strain, and it is hoped that the information in this paper will supplement the meager data in the literature (Griffith and Farris, 1).

The rats used in these studies were of the Wistar strain, and from the same stock. The stock animals were housed six to a cage; the other animals were placed in individual cages. Tap water and diets were fed *ad libitum.* The composition of the diets has been given in previous papers (2, 3).

Animals from the stock colony were selected through 3 to 14 months of age. Rats on the other diets were 3 months of age when blood sampling was begun, and were sampled each month until they were 8 months of age. Eighteen stock rats were sampled, and with the exception of those fed synthetic diet I, there were five males and five females in each of the other groups. The group consuming synthetic diet I was composed of six rats of each sex.

Blood from a tail clip was collected in a paraffin cup containing heparin. All sampling was done in duplicate by the same two persons at the same time of day. Certified Thoma pipettes were used, and the blood was diluted with Osgood's solution. The pipettes were shaken for 3 minutes and the counts made in certified Newbauer im-

ARTICLE 31-8

proved hemacytometers. Chambers were checked for uneven distribution and were discarded if irregularities were evident. The average value of four chambers was used in calculating the cell count.

Duplicate smears for differential counts were made on standard alcohol and acid cleaned slides, dried quickly, and stained with Wright's stain. Three hundred consecutive cells were counted.

Mean values for the total and differential leucocyte counts for rats on each of the diets are presented in Table 1. Within any of the dietary groups, the total and differential leucocyte counts differed greatly for any given count regardless of sex or age. The differences in the mean values between the dietary groups are slight, and all are well within the "normal" ranges proposed by Griffith and Farris (1).

TABLE 1—*Mean leucocyte values for adult albino rats from the same stock fed different diets*

Dietary group	Thousand per cmm.	Lymphocytes	Monocytes	Polymorphonuclear cells	Eosinophils	Basophils
		percent	percent	percent	percent	percent
MALE						
Stock						
Mean	8.6	66.9	7.9	23.7	3.6	0.20
Range	....	57.3 — 86.5	3.0 — 9.3	5.2 — 30.3	1.3 — 6.3	0.0 — 0.65
Synthetic I						
Mean	9.1	77.6	3.3	17.1	1.6	0.15
Range	....	54.6 — 89.6	1.3 — 11.0	8.6 — 40.3	0.0 — 6.3	0.0 — 1.3
Synthetic II						
Mean	9.1	67.7	5.3	24.7	1.9	0.17
Range	....	55.3 — 86.5	1.0 — 10.6	9.5 — 36.1	0.0 — 4.6	0.0 — 1.0
Synthetic I +Garlic						
Mean	8.0	79.9	3.0	15.5	1.1	0.12
Range	....	59.3 — 89.3	0.6 — 6.3	5.6 — 33.3	0.0 — 5.0	0.0 — 0.6
Barley						
Mean	8.7	68.3	4.4	24.8	2.1	0.06
Range	....	49.0 — 85.0	2.0 — 8.0	12.0 — 42.2	0.6 — 4.0	0.0 — 0.5
Corn						
Mean	8.2	68.3	4.1	25.8	1.0	0.10
Range	....	49.3 — 84.0	2.0 — 6.6	14.0 — 44.6	0.0 — 2.3	0.0 — 0.3
FEMALE						
Stock						
Mean	8.3	63.7	7.4	25.7	2.6	0.09
Range	....	43.3 — 77.4	4.0 — 13.0	14.0 — 43.3	0.3 — 4.3	0.0 — 0.6
Synthetic I						
Mean	8.4	75.9	3.3	16.5	1.7	0.18
Range	....	53.5 — 96.0	0.6 — 9.0	1.0 — 41.6	0.0 — 5.0	0.0 — 1.0
Synthetic II						
Mean	8.7	70.9	3.8	23.2	2.1	0.02
Range	....	49.0 — 87.0	0.0 — 6.0	8.8 — 41.0	0.6 — 7.3	0.0 — 0.3
Synthetic I +Garlic						
Mean	8.7	76.1	3.3	19.3	1.1	0.09
Range	....	58.0 — 90.3	0.6 — 7.3	6.6 — 35.6	0.3 — 2.3	0.0 — 0.6
Barley						
Mean	9.2	72.9	3.8	20.9	2.2	0.09
Range	....	56.0 — 87.8	1.5 — 8.6	3.6 — 37.6	0.3 — 6.3	0.0 — 1.0
Corn						
Mean	8.5	69.0	4.0	25.3	1.5	.00
Range	....	55.3 — 86.0	0.3 — 8.6	11.0 — 38.6	0.0 — 3.0	0.

TABLE 2—*Comparison of mean leucocyte values for albino rats of different strains with animals from this study*

Authors	No. of rats	Total		Differential							
		Thousand per cmm.		Lymphocytes		Monocytes		Polymorpho-nuclears		Eosinophils	
				Percent		Percent		Percent		Percent	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Griffith and Farris (1).......	50	9.0		78.0		1.0		20.0		2.0	
Reich and Dunning (4).....	2656	15.4	16.2	63.0	65.0	6.0	6.0	29.0	27.0	2.0	2.4
This work.......	72	8.6	8.6	71.5	71.4	4.6	4.3	21.9	21.8	1.8	1.8

Although Reich and Dunning (4) found a much higher mean total count in their studies of other strains, (15.8 thousand per cubic mm. of blood), their values for the differential count are similar to those of Griffith and Farris (1). Table 2 presents the data of these authors for comparison with the average values found in this study.

Averages for all the females by months indicate that the total counts increased sharply during the sixth and seventh months when they were bearing or rearing young. Average values for the male rats increased gradually, but were higher at 3 months than were the average female values (Table 3).

TABLE 3—*Mean total leucocyte values for albino rats by months*

Sex of animals	Age in months					
	3	4	5	6	7	8
Males.....................	8.5	8.5	8.6	8.9	9.1	9.2
Females.................	7.7	8.1	8.6	9.9	8.7	7.7

SUMMARY

Total and differential white blood-cell counts of albino rats of the Wistar strain which had been fed different diets are presented.

In female rats the leucocyte count increases during reproduction, then recedes. In male rats there is a gradual increase with no recession up to the age of 9 months.

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AN IMPROVED METHOD FOR THE PREPARATION OF THE ANTIBACTERIAL OIL FROM *Allium sativum* L.

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SECTIONS OF AGRICULTURAL CHEMISTRY AND HORTICULTURE

THE PUNGENT and irritating substances contained in the tissues of the members of the botanical genus *Allium* have long been of considerable interest to chemists and biologists. Some principles derived from, or present in, the tissues have been considered to be responsible for antibacterial (1-6) and antimycotic (7, 8) properties.

In 1944 Huddleson *et alii* (9) reported the isolation of a crude garlic extract that had strong antibacterial properties. Concurrently Cavallito and Bailey (10) and Cavallito, Buck and Suter (11) isolated from garlic a substance with the empirical formula $C_6H_{10}S_2O$. This substance also showed marked antibacterial action and, according to their report, differed in this respect from substances previously claimed to be the antibacterial principle of the garlic bulb (1, 2, 4, 12, 13, 14). Recently, Rao, Rao and Venkataraman (15) reported the preparation of an active oil and a yield 2.5 times greater than that obtained by Cavallito *et alii* (10).

The authors have used the methods mentioned (9, 10, 15) for the preparation of the active oil. However, in most cases the formation of troublesome emulsions occurred during the extraction of the aqueous alcoholic solutions with ether or chloroform. By employing these methods an oil insoluble in water was also obtained with a much lower antibacterial activity than that of the water-soluble part of the product. In the preparation of their oil, Rao *et alii* (15) did not state that they made a separation of their product with water. This may account for the fact that their preparation had a lower activity than the oil isolated by Cavallito *et alii* (10) since their product must have contained an appreciable quantity of the water-insoluble oil to be described in this paper.

ARTICLE 31-9

The present publication is concerned chiefly with an improvement in the method of preparing the water-soluble garlic oil with antibacterial properties. Since garlic oil is quite stable in water (16) and less stable in organic solvents, attempts have been made to reduce the length of time that the oil is kept in organic solvents during preparation. In the preparation procedure to be described, the use of ethanol has been discontinued to avoid concentration of large volumes of this solvent. The initial extraction consists of macerating the garlic cloves with water in a Waring Blendor to permit enzymatic hydrolysis of the precursor, to release the active oil (16, 17, 18), and to insure a better extraction of the active substance. The use of "Hyflo Super-Cel" made possible the filtration of this macerate through a Büchner funnel. By employing this technique, the offensive odor otherwise imparted to the skin and clothing by squeezing the macerate through a muslin cloth can be almost entirely eliminated. The formation of emulsions, generally encountered in extracting aqueous solutions of garlic with ether, was practically eliminated by digesting the solution with pepsin before extraction. Extraction of the digested solution with ether, separation with water, and re-extraction with ether yielded a light straw-colored oil.

The use of ether which has not been freed of peroxides and freshly redistilled, or the heating of the ether solution, or delaying the removal of the ether from the oil, or permitting the oil to stand at room temperature yields a product of which a portion is insoluble in water.

EXPERIMENTAL

One kilogram of garlic cloves was macerated with 1500 ml. of distilled water in a Waring Blendor. The maceration was carried out with small batches of 200 gm. of cloves and 300 ml. of distilled water. After blending all the lot, 125 gm. of "Hyflo Super-Cel" was stirred into the entire macerate. The suspended material was filtered off on a size J Büchner funnel; Whatman No. 4 grade filter paper with a dry ½-inch "Hyflo Super-Cel" pad was used. When the residue was fairly dry, it was washed with two portions of 200 ml. each of distilled water. The filtrate was adjusted to pH 2 with 5 normal sulfuric acid, and then 20 ml. of a 5-percent pepsin solution was added. The liquid was digested in a water bath at 37°C. for 18 hours. At the end of the digestion period, 50 gm. of "Hyflo Super-Cel" was added and the solution filtered through a Büchner funnel by the

technique described above. The residue was washed with 100 ml. of distilled water and the filtrate then extracted with 350 ml., 175 ml., 150 ml., and 100 ml., respectively, of peroxide-free, freshly redistilled ether in a separatory funnel. Occasionally, a slight emulsion may form. This may be broken by the addition of ether to the solution, filtration of the ether-emulsified portion through a Büchner funnel by suction, and subsequent separation of the ether phase in a separatory funnel.

The first extraction was transferred immediately to a round-bottomed flask containing 250 ml. of distilled water. The ether was removed as rapidly as possible by distillation (using a water aspirator) with nitrogen at 16 mm. pressure and room temperature. The second, third, and fourth extracts were added, respectively, to the same flask and the ether removed as described for the first extract. When the solvent has been removed, the flask is stoppered and shaken vigorously to effect solution of the oil in water.

Poor technique and impure solvents will produce a considerable amount of water-insoluble oil containing 46.69 percent C, 5.33 percent H and 40.8 percent S, and having a $N_D^{20} = 1.597$, Sp. g. $\frac{20}{20} = 1.166$ and a molecular weight 158.3 (which changes over night at 25°C. to a molecular weight of 215.1). The oil is soluble in acetone, ethyl acetate, ether, chloroform, benzene, dioxane, ethanol, and methanol. It is slightly soluble in n-hexane and n-heptane. Upon treatment of the insoluble oil with l-cysteine (11), the latter is oxidized to l-cysteine.

Calculated for $C_6H_{12}O_4N_2S_2$: 29.97 percent C, 4.99 percent H, 26.69 percent S, 11.66 percent N. Found: 30.45 percent C, 5.22 percent H, 26.76 percent S, 11.28 percent N. Reported values:

$[\alpha]_D^{30} = -200°$ to $-203°$; m.p. of N phenylurea derivative 160°C. Observed values:

$[\alpha]_D^{25} = -204°$ in 1.0 N hydrochloric acid where C = 1.0 percent; m.p. of N phenylurea derivative 159°C.

The water-insoluble oil should be removed by filtration before neutralization. However, if instructions are carefully followed, the entire yield will be a water-soluble product having strong antibacterial properties. The organic acids and small quantities of sulfuric acid were neutralized by stirring the solution in a 400-ml. beaker with

small portions of barium carbonate until pH 5 was attained. The insoluble barium salts of the acids were filtered off by suction on a Büchner funnel and the residue washed with water. Care must be exercised at this point not to make the solution too alkaline, as a high pH will inactivate the antibacterial principle (11). The filtrate was extracted with 100 ml. of peroxide-free, freshly redistilled ether and then three times with 50-ml. portions. The first ether extract was transferred immediately to a 500-ml. round-bottomed flask and the solvent removed rapidly under nitrogen at 16 mm. pressure and room temperature. The other extracts were transferred separately to the same flask and the solvent removed as previously described. The oil can be dried more rapidly if it is taken up in peroxide-free, freshly redistilled ether and the supernatant ether liquid decanted from the water particles. The ether was again removed *in vacuo* with a water aspirator, and the oil was then dried at 1 mm. pressure at room temperature for 20 minutes. Very seldom is any solid residue found in the oil. If present it may be removed by filtering through a small Hirsch funnel by suction.

The yield of a light-yellow water-soluble oil varies from 2.2 to 4.0 gm. per 1000 gm. of garlic cloves. Variety of garlic and technique used are the principal factors in determining the yield of oil. The oil is very unstable and must be immediately dissolved in water and stored at low temperature. The oil contained 44.31 percent C, 6.20 percent H, 39.52 percent S, and had a molecular weight of 156.8 (which changed at 25° C. overnight to a molecular weight of 215.1). Calculated for $C_6H_{10}S_2O$: 44.44 percent C, 6.17 percent H and 39.51 percent S; molecular weight, 162. Observed values: N_D^{20} = 1.566, Sp. g. $\frac{20}{20}$ = 1.136; reported values (10): N_D^{20} = 1.561, Sp. g. $\frac{20}{20}$ = 1.114. The oil was soluble in water, ethanol, methanol, acetone, ethyl acetate, ether, chloroform, benzene, n-hexane and n-heptane.

The active oil reacted with l-cysteine (11) to give S— (thioallyl) cysteine in 85-percent yields. The derivative was recrystallized from dilute ethanol until a constant melting point (dec.) was attained. The S— (thioallyl) cysteine had the following composition and properties: Calculated for $C_6H_{11}O_2NS_2$: 37.31 percent C, 5.70 percent H, 7.25 percent N. Found: 37.14 percent C, 5.35 percent H, 7.71 per-

cent N; m.p. (dec.) 186° C, $[\alpha]^{25}_{D} = -135°$ in 1.0 N hydrochloric acid where C = 1.0 percent. Reported values (11): m.p. (dec.) 185°, $[\alpha] = -150°$ (approximately). These analyses and properties confirm the findings reported by Cavallito *et alii* (10, 11) with the exception of a variation found in the specific gravity and refractive index of the oil and the specific rotation of S— (thioallyl) cysteine.

The oil had strong antibacterial properties when tested against gram-negative, gram-positive, and acid-fast organisms.

Acknowledgments are made to Mr. Jack Snyder for the molecular weight determinations, Mr. Carl Redemann for the micro analyses and to the late Dr. Frithjof Setter for some suggestions regarding extraction technique.

SUMMARY

1. An improved method has been described for the preparation of a water-soluble garlic oil in good yields from *Allium sativum* L. The oil has strong antibiotic properties and the composition is in agreement with that reported by Cavallito *et alii* (11).

2. The isolation and composition of a water-insoluble garlic oil having only slight antibacterial properties is reported.

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POTATO RING ROT CONTROL THROUGH USE OF SEED DIPS AND THE DISINFESTED STATIONARY CUTTING KNIFE

By L. CARL KNORR[1] *and* JOHN R. VAUGHN
SECTION OF BOTANY AND PLANT PATHOLOGY

THE GREATEST increase of potato ring rot occurs during the seed-cutting operation. Prerequisite to its spread is introduction of the causal bacterium [*Corynebacterium sepedonicum* (Spieck. and Kotth.) Skapt. and Burkh.] into the vascular bundles of the potato—and at no other stage in potato production is the bacterium assured of such positive access to the infection court as when the contaminated cutting knife passes through the vascular ring.

Theoretically the killing of ring rot bacteria that have been introduced with a contaminated knife – killing such as might be afforded by a cut-seed dip – would control the disease. Since the practice of dipping is already familiar to potato growers, and the possibility exists of finding a dip that will work against ring rot as well as against scab and rhizoctonosis, numerous disinfestants were tested as cut-seed treatments for ring rot control.

METHODS AND MATERIALS

Tubers to be inoculated were cut with knives that had previously been passed through potatoes diseased with ring rot. The frequency of knife recontamination varied with the different tests, and rates are indicated in the tables. Seed pieces mentioned in tables 1 to 5 were dipped approximately 15 minutes after cutting of the first seed piece. Since some reports (2, 5) indicate that more satisfactory control can be expected from dropping the seed pieces directly into the treating solution, seed pieces mentioned in tables 6 to 8 were treated immediately after cutting.

[1]Solely responsible for data presented in Tables 1 through 9, and jointly with junior author for data in Table 10.

ARTICLE 31-10

Field layouts consisted of randomized rows each planted to 100 seed pieces and replicated four times. Planting was done by hand, with precautions being observed to prevent contamination of seed after treating. Indication of a dip's efficacy was based either on the amount of ring rot wilting in the field or on the amount of macroscopically visible ring rot in the daughter tubers, the particular test used being indicated in each table.

DATA

Table 1 presents results obtained in testing the effectiveness, among other treatments, of mercuric chloride (1: 1000, 1½ - 2 hours), and shows that this cut-seed dip very satisfactorily controlled ring-rot spread, reducing it by 20 bushels per acre below the untreated plantings. However, the figure under "total" indicates that the treatment also controlled potatoes, significantly reducing yield.

Table 1 also reports results obtained with a rotary cutting knife (indicated by the letter "S"), and shows that this device gave as effective control of ring rot as did mercuric chloride, and, contrary to results

TABLE 1—*Comparison of effects resulting from treatment consisting of seed dip (T), ultra violet selection (U), and rotary knife (S). (Charles Huff farm, McLean, New York)*

Effects	Tubers in bushels per acre		
	Healthy	Diseased	Total
Main—Increase or decrease due to treatment:			
U	− 6.8	− 2.0	− 8.9
S	20.4**	−19.6**	0.8
T ($HgCl_2$ 1:1000, 1½-2 hrs.)	− 9.7	−20.3**	−30.0**
Interactions—Increase or decrease "together" over "separately:"			
US	− 9.1	2.5	− 6.6
UT	− 2.7	2.0	− 0.7
ST	−28.5**	19.5**	− 9.0
UST	6.0	− 1.9	4.1
Least significant differences	±13.0	± 3.9	±12.7

**Significantly different from untreated plantings at 1 percent level.

Variety: Katahdin, containing 2 percent ring rot.
Date planted: June 25, 1943.
Date final ring-rot reading: October 9, 1943.
Knife recontamination rate: 1 cut through tuber infected with ring rot to 5 through seed.

TABLE 2—*Comparison of effects resulting from treatment consisting of seed dip (T), picker planter (P), and rotary cutting knife (S). (Steward Crounse farm, Sennett, New York)*

Effects	Tubers in bushels per acre		
	Healthy	Diseased	Total
Main—Increase or decrease due to treatment:			
T ($HgCl_2$ 1:500 acidulated, 5 min.)	−59.0**	−9.3**	−68.3**
P	−16.4	1.3	−15.1
S	2.7	−4.3**	− 1.6
Interactions—Increase or decrease "together" over "separately":			
TP	12.6	−0.7	11.9
TS	−14.1	4.0**	−10.1
PS	− 1.6	−0.5	− 2.1
STP	− 6.4	0.3	− 6.1
Least significant difference	±19.5	±2.7	±19.3

**Significantly different from untreated plantings at 5 percent level.

Variety: Katahdin, containing approximately 2 percent ring rot.
Date planted: June 19, 1943.
Date final ring-rot reading: October 20, 1943.
Knife recontamination rate: 1 cut through tuber infected with ring rot to 5 through seed.

with mercuric chloride, produced no significant deleterious effect on total yield.

Table 2 shows against the letter "T" that mercuric chloride 1:500, acidulated with 0.2 percent hydrochloric acid, exposure 5 minutes, was effective in reducing ring rot, but that it also reduced total yield. Incidentally, the value against "S" duplicates findings reported in Table 1, that the rotary knife significantly reduced the amount of ring rot and that it exerted no deleterious effect on total yield.

Table 3 reports results obtained using as seed dips 1) unadjusted Malachite Green 1:3000, 2) alkalized Malachite Green 1:3000, and 3) mercuric chloride 1:500 acidified with 0.2 percent hydrochloric acid. The unbuffered Malachite Green did not give significant differences compared with no treatment. The alkalized Malachite Green produced a significant increase in healthy and total tubers as compared with no treatment, and an insignificant decrease in number of diseased tubers. Mercuric chloride gave highly significant increases in yields of healthy and of total tubers and also a highly significant decrease in the number of ring-rot infected tubers. This is in marked contrast with results obtained in the two foregoing tests, and this diversity

TABLE 3—*Comparison of three seed treatments for the control of potato ring rot. (Messrs. C. and R. Van Duser farm, Auburn, New York)*

	Treatments			
	Mal. Green (10 min.)	Mal. Green Alkali (10 min.)	$HgCl_2$, 1:500 Acidif. (5 min.)	Untreated
	Yield (bushels per acre)			
Healthy	107.0	134.6	160.9	102.0
Diseased	27.3	22.4	0.7	32.2
Total	134.3	157.0	161.6	134.2
Differences between treatments	A-D	B-D	C-D	
Healthy	5.0	32.6**	58.9**	
Diseased	−4.9	−9.8	−31.5**	
Total	0.1	22.8**	27.4**	

Least significant differences	5 percent level*	1 percent level**
Healthy	18.2	26.2
Diseased	12.4	17.8
Total	13.5	19.4

Variety: Katahdin, containing approximately 2 percent ring rot.
Date planted: June 9, 1943.
Date final ring-rot reading: October 6, 1943.
Knife recontamination rate: 1 cut through tuber infected with ring rot to 5 through seed.

TABLE 4—*Comparison of three seed treatments for the control of potato ring rot. (Messrs. Shaw and Uhl farm, Southport, New York)*

	Treatments			
	Formalin (1 hr.)	Semesan Bel (½ min.)	Yel. Oxide Mercury (2 min.)	Untreated
	Yield (bushels per acre)			
Healthy	170.1	183.6	162.8	173.6
Diseased	13.4	2.9	0.8	8.8
Total	183.5	186.5	163.6	182.4
Differences between treatments	A-D	B-D	C-D	
Healthy	−3.5	10.0	−10.8	
Diseased	4.6	−5.9	− 8.0	
Total	1.1	4.1	−18.8	

Least significant differences	5 percent level	1 percent level
Healthy	51.2	73.6
Diseased	8.3	12.0
Total	54.9	78.8

Variety: Not indicated. Maine "Selected" seed containing approximately 2 percent ring rot.
Date planted: June 17, 1943.
Date final ring-rot reading: September 12, 1943.
Knife recontamination rate: 1 cut through tuber infected with ring rot to 5 through seed.

TABLE 5—*Comparison of three seed treatments for the control of potato ring rot. (Messrs. Shaw and Uhl farm, Southport, New York)*

	Treatments			
	Crystal Violet (10 min.)	Crystal Violet Alkali (10 min.)	Formalin + Y. Oxide of Mercury (2 min.)	Untreated
	Yield (bushels per acre)			
Healthy	112.3	75.1	199.7	145.0
Diseased	2.4	3.4	10.3	1.2
Total	114.7	78.5	210.0	146.2
Differences between treatments	A-D	B-D	C-D	
Healthy	−87.4**	−124.6**	−54.7*	
Diseased	− 7.9*	− 6.9*	− 9.1*	
Total	−95.3**	−131.5**	−63.8**	

Least significant differences	5 percent level*	1 percent level**
Healthy	40.0	57.4
Diseased	6.5	9.3
Total	38.1	54.8

Variety: Not indicated. Maine "Selected" seed containing approximately 2 percent ring rot.
Date planted: June 17, 1943.
Date final ring-rot reading: September 12, 1943.
Knife recontamination rate: 1 cut through tuber infected with ring rot to 5 through seed.

parallels the conflicting reports in the literature regarding the use of mercuric chloride as a cut-seed dip, indicating that details of the treatment need investigating before it can be recommended.

Table 4 shows the results obtained with formalin, 1 pint in 30 gallons of water, with Semesan Bel at manufacturer's recommended dilution, and with yellow oxide of mercury, 1 pound in 20 gallons of water. None of these treatments produced either significant beneficial or significant injurious results when compared with no treatment.

Table 5 shows results obtained with Crystal Violet 1:3000, the same solution alkalized, and a mixture of yellow oxide of mercury, 0.5 percent, and formalin, 1.7 percent, in water. All three treatments reduced significantly the amount of ring rot, but also exerted a significant deleterious effect on the yield of total tubers.

Table 6 shows the control obtained with various concentrations and times of dipping in two of the newer quaternary disinfectants—di-isobutyl cresoxy ethoxy ethyl dimethyl benzyl ammonium chloride (Hyamine 10X brand) and cetylpyridinium chloride (Ceepryn brand). Also reported here are results with zinc oxide, a material recommended in Australia for the treating of cut seed pieces (1). All treatments

TABLE 6—*Comparison of six seed dips for the control of potato ring rot. (Ronald Clark farm, Gaylord, Michigan)*

Disinfectant	Concentration (active ingredient)	Time (min.)	Hills/four 100-foot replications		
			Healthy	Diseased	Total
1. Hyamine 10X	1:1000	to 5	169	162**	331**
2. Hyamine 10X	1:10000	to 5	210	160**	370
3. Hyamine 10X	1:1000	15–30	227	84**	311**
4. Hyamine 10X	1:10000	15–30	248	129**	377
5. Zinc oxide + wetter	4 pounds in 4 gallons water	15–30	228	119**	347
6. Sterile check		—	349	10**	359
7. Ceepryn	1:1000	15–30	238	45**	283**
8. Inoculated check		—	152	229	381

*Significantly different from untreated plantings at 5 percent level.
**Significantly different from untreated plantings at 1 percent level.

Variety: Chippewa (Sterile check indicates that ring rot was present in this seed stock).
Date planted: May 25, 1946.
Date final ring-rot reading: September 6, 1946.
Knife recontamination: before each cut.

resulted in significant control, though not to a degree sufficient to suggest that these chemicals be recommended against knife-spread ring rot. The 1:1000 concentrations of the quaternaries also reduced significantly the total yield, and the di-isobutyl at 1:1000 (treatments 1 and 3) was observed to have inhibited corking over.

Table 7 shows control obtained with the following: 1) alkyl dimethyl benzyl ammonium chlorides (Roccal brand), 2) N(acyl colamino

TABLE 7—*Comparison of seven seed dips for the control of potato ring rot. (John Oberthur farm, Talbot, Michigan)*

Disinfectant	Concentration (active ingredient)	Time (min.)	Pounds tubers/four 100-foot replications		
			Healthy	Diseased	Total
1. Roccal	1:1000	to 30	236.5	27.8**	264.3
2. Emulsept	1:1000	to 30	268.7	32.1**	300.8
3. Steri-Chlor	2000 ppm. available Cl_2	to 30	93.6	4.8**	98.4**
4. Tetrosan	1:1000	to 30	249.9	23.2**	273.2
5. Isothan Q-15	1:1000	to 30	238.2	13.1**	251.3
6. Hyamine 1622	1:1000	to 30	236.4	20.2**	256.6
7. Puratized	1:1000	to 30	160.3	7.1**	167.4**
8. Untreated check		—	192.0	73.5	265.5

*Significantly different from untreated plantings at 5 percent level.
**Significantly different from untreated plantings at 1 percent level.

Variety: Russet Rural. No systemic ring rot encountered while cutting 3200 seed pieces, nor was the disease observed in the 100 hills planted to whole, uncontaminated seed.
Date planted: June 3, 1946.
Date final ring-rot reading: October 6, 1946.
Knife recontamination: before each cut into healthy seed.

formyl-methyl pyridinium chloride) (Emulsept brand), 3) sodium para-toluene-sulfonchloramide (Steri-Chlor brand), 4) alkyl dimethyl 3,4-dichlorobenzyl ammonium chloride (Tetrosan brand), 5) lauryl isoquinolinium bromide (Isothan Q-15 brand), 6) di-isobutyl phenoxy ethoxy ethyl dimethyl benzyl ammonium chloride (Hyamine 1622 brand), and 7) phenyl mercuri triethanol ammonium lactate (Puratized brand). The data show that all disinfectants produced highly significant control of ring rot, though all with the exception of Tetrosan and Emulsept caused reductions in total yield, Steri-Chlor and Puratized significantly so. Corking over was seriously interfered with after dipping in Steri-Chlor at the strength used.

Table 8 reports results obtained with sodium hypochlorite and with alkyl dimethyl benzyl ammonium chlorides at various concentrations and exposures as seed dips. No treatment gave a significant difference nor an adequate control of the disease.

From the findings reported above it may be concluded that there are dips which will reduce materially the spread of ring rot. None of them, however, gives a sufficiently high degree of control to warrant adoption. Adoption is further unwarranted because injury to cut seed results from use of some of these chemicals. It is also quite awkward to have to cut directly into the treating solution. Finally, the advisability of seed dips is questioned because of data recently announced by the Colorado Agricultural Experiment Station (3, 4) showing that a thin trickle of disinfectant (mercuric chloride) running constantly over a stationary cutting knife will give excellent and quite simple control of knife-initiated ring-rot spread. The Colorado method consists of

TABLE 8—*Comparison of two seed dips at various concentrations for the control of potato ring rot. (Otto Winkel farm, Cooks, Michigan)*

Disinfectant	Concentration (active ingredient)	Time (min.)	Pounds tubers/four 100-foot replications		
			Healthy	Diseased	Total
1. Roccal	1:1000	to 5	316.5	27.5	344.0
2. Roccal	1:10000	to 5	297.5	25.0	322.5
3. Roccal	1:1000	15–30	268.0	13.0	281.0
4. Roccal	1:10000	15–30	280.0	28.0	308.0
5. Sodium hypochlorite	400 ppm. available Cl_2	to 5	271.0	30.5	301.5
6. Untreated check		—	285.0	24.5	309.5

Variety: Pontiac. No systemic ring rot encountered while cutting 3200 seed pieces, nor was the disease observed in the 100 hills planted to whole, uncontaminated seed.
Date planted: June 8, 1946.
Date final ring-rot reading: October 1, 1946.
Knife recontamination: before each cut into healthy seed.

Fig. 1. Cutting seed with a "trickle knife" (stationary knife with corrosive sublimate trickling down the blade) to check spread of potato ring rot by cutting knife. (Photographed in cooperation with Farm Quarterly.)

placing a can of disinfectant above the cutting knife, fastening one end of a rubber tubing to a petcock at the bottom of the can, and attaching the other end of the tubing to the top of the stationary cutting knife. The petcock is opened sufficiently to permit a thin trickle of disin-

TABLE 9—*Comparison of seven stationary knife disinfectants for the control of potato ring rot. (Carl Hessler and Son farm, Rockford, Michigan)*

Disinfectant	Concentration (active ingredient)	Hills/four 100-foot replications		
		Healthy	Diseased	Total
1. Mercuric chloride	1:500	239	0	239
2. Tetrosan	1:1000	252	20	272
3. Roccal	1:1000	211	2	213
4. Hyamine 1622	1:1000	215	0	215
5. Onyxide	1:1000	229	3	232
6. Copper sulfate	2 pounds in 10 gallons water	120	0	120
7. Isothan Q-15	1:1000	235	5	240
8. No disinfectant—check		193	45	238

Variety: Chippewa (Michigan certified). No systemic ring rot encountered while cutting 3200 seed pieces, nor was the disease observed in the 100 hills planted to whole, uncontaminated seed.
Date planted: June 20, 1946.
Date final ring-rot reading: September 26, 1946.
Knife recontamination: after each 5 cuts into healthy seed.

fectant to run continuously down the sides of the knife. Figure 1 illustrates the device as used in the following trials.

The "trickle knife" was tested in Michigan under field conditions in 1946, with various chemicals as disinfectants, including 1) mercuric chloride, 2) alkyl dimethyl 3,4-dichlorobenzyl ammonium chloride (Tetrosan brand), 3) alkyl dimethyl benzyl ammonium chlorides (Roccal brand), 4) di-isobutyl phenoxy ethoxy ethyl dimethyl benzyl ammonium chloride (Hyamine 1622 brand), 5) alkenyl dimethyl ethyl ammonium bromide (Onyxide brand), 6) copper sulfate, and 7) lauryl isoquinolinium bromide (Isothan Q-15 brand). The cutting knife was recontaminated by passage through a ring-rot infected potato before making five cuts into seed pieces ultimately planted. The field layout was of the same size and arrangement as that used in the experiments already reported. Table 9 shows the degree of control obtained with each of these disinfectants. While all of them markedly reduced the amount of ring rot, complete control was obtained only with Hyamine 1622, mercuric chloride, and copper sulfate.

Further testing of the "trickle knife" was carried out in 1947, with confirmatory runs being made of the materials found to be best in the 1946 tests, mercuric chloride 1:500, copper sulfate, 2 pounds in 10 gallons water, and Hyamine 1622, 1:1000. Additional materials tested were Roccal 1:500, Roccal 1:1000, Rohm and Haas Experimental Product L4552 1:500, and Sharples Experimental Product EC2550 1:500. The field layout was the same as that previously described.

TABLE 10—*Comparison of seven stationary knife disinfectants for the control of potato ring rot. (Lloyd Swanson farm, Sands, Michigan)*

Disinfectant	Concentration (active ingredient)	Hills/four 100-foot replications		
		Healthy	Diseased	Total
1. Mercuric chloride	1:500	377***	22***	399
2. Roccal	1:500	177**	220**	397
3. Roccal	1:1000	85	310	395
4. Hyamine 1622	1:1000	139*	257*	396
5. R & H L4552	1:500	108	287	395
6. Sharples EC2550	1:500	99	289	388**
7. Copper sulfate	2 pounds in 10 gallons water	349***	42***	391*
8. No disinfectant—check		69	331	400

Differences between treatments.	1 – 8	2 – 8	3 – 8	4 – 8	5 – 8	6 – 8	7 – 8
Healthy	308	108	16	70	39	30	280
Diseased	309	111	21	74	44	42	289
Total	1	3	5	4	5	12	9

Least significant differences	5 percent level*	1 percent level**	0.1 percent level***
Healthy	65.50	89.12	120.29
Diseased	65.13	88.62	119.62
Total	6.68	9.09	12.27

Variety: Green Mountain. No systemic ring rot encountered while cutting 3200 seed pieces, nor was the disease observed in the 200 hills planted to whole, uncontaminated seed.
Date planted: June 6, 1947.
Date final ring-rot reading: September 3, 1947.
Knife recontamination rate: after each 5 cuts into healthy seed.

Table 10 reaffirms the efficacy of mercuric chloride and copper sulfate as stationary cutting knife disinfectants. Only 5.5 percent of seed pieces cut with a knife treated with mercuric chloride showed ring rot, and 10.7 percent of those cut with a knife treated with copper sulfate showed ring rot. When no disinfectant was used, the percentage of ring rot amounted to 82.8. Both mercuric chloride and copper sulfate proved highly significant in stopping ring rot (beyond the 0.1 percent level) when compared with the untreated plantings. The difference between these two chemicals is not significant, though the trend favors mercuric chloride. Other disinfectants showed lesser degrees of control.

DISCUSSION AND CONCLUSION

The possibility of using seed dips appears at first to hold promise for halting knife spread of ring rot. Growers would be ready to adopt dips because of previous familiarity with this method of treating seed, while they might oppose adoption of the rotary cutting knife. Furthermore, a material might be found combining ring-rot control with that

of scab and rhizoctonosis for which dips are already in common use. With these advantages of dips in mind, numerous chemicals were tested under field conditions, including some of the common potato treatments, various bacteriostatic dyes, and the newer quaternary compounds. As testing proceeded, various inadequacies of dipping came to light. Some materials, at the strengths tested, failed to control ring rot at all; one disinfectant, formalin, 1 pint in 30 gallons, even resulted in more ring rot than that shown by the untreated plantings. Other materials like mercuric chloride, while giving adequate control of ring rot, produced injury to the seed and caused a reduction in yield below that of untreated plantings. Some other chemicals gave a fair degree of control but none to an outstanding degree. In addition, all dips required the cutting of seed directly into the solution—and this proved to be an awkwardness no grower could be asked to tolerate.

Further search for a ring-rot dip became less justifiable on publication by Colorado Agricultural Experiment Station workers (3, 4) of results showing the efficacy of the stationary disinfected cutting knife for controlling ring rot. This device, notable for its simplicity, was tested under Michigan conditions for the past 2 years, and results confirm those of the Colorado Station workers. The best material for continuously disinfecting the knife proved to be mercuric chloride, 1: 500. The knife is so simple and cheap to construct that any grower can provide himself with protection from the spread of ring rot. No alteration in customary cutting with stationary knives is required, and for growers who still cut with paring knives, adoption of the stationary knife with "trickle" attachment will actually accelerate the cutting operation.

Details of constructing the "trickle knife" can be inferred from Fig. 1. All that is required is a can or crock with a petcock at bottom, rubber tubing extending from the petcock to the top of the knife blade, and a sleeve of lamp wick inserted between blade and tubing to insure trickling of solution over both surfaces of the knife. The can is filled with mercuric chloride solution (1: 500), the petcock opened so that a thin stream runs down each side of the upright knife, and seed cutting is carried out in the customary fashion.

SUMMARY

Hope of finding a cut-seed dip for knife-spread ring rot led to the testing at different concentrations and exposure times of 1) mercuric chloride, 2) mercuric chloride acidified, 3) yellow oxide of mercury,

4) formalin, 5) yellow oxide of mercury plus formalin, 6) Semesan Bel, 7) sodium hypochlorite, 8) sodium paratoluene sulfonchloramide, 9) Malachite Green, 10) Malachite Green alkalized, 11) Crystal Violet, 12) Crystal Violet alkalized, 13) alkyl dimethyl benzyl ammonium chlorides, 14) N(acyl colamino formyl-methyl pyridinium chloride), 15) lauryl isoquinolinium bromide, 16) alkyl dimethyl 3, 4-dichlorobenzyl ammonium chloride, 17) di-isobutyl phenoxy ethoxy ethyl dimethyl benzyl ammonium chloride, and 18) phenyl mercuri triethanol ammonium lactate. No cut-seed dip tested, however, possessed sufficient advantages to warrant its recommendation.

The disinfested stationary cutting knife was tested under Michigan conditions and with the following knife disinfectants: 1) mercuric chloride, 2) copper sulfate, 3) alkenyl dimethyl ethyl ammonium bromide, 4) alkyl dimethyl 3, 4-dichlorobenzyl ammonium chloride, 5) lauryl isoquinolinium bromide, 6) di-isobutyl phenoxy ethoxy ethyl dimethyl benzyl ammonium chloride, 7) alkyl dimethyl benzyl ammonium chlorides, 8) Rohm and Haas Experimental Compound L4552, and 9) Sharples Experimental Compound EC2550. Best control was obtained with mercuric chloride, and this material used with the "trickle knife" is recommended for control of knife-spread potato ring rot in Michigan.

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STRAIN DIFFERENCES IN THE MONTMORENCY CHERRY

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MONTMORENCY is one of the oldest of the cultivated varieties of the sour cherry. It was grown in Europe long before the advent of commercial fruit production in this country and was one of the varieties introduced early in America. Some of the many names applied to the variety as it grows in Europe suggest clearly that a number of strains have been developed and found their way into cultivation. In this country it is generally recognized and grown as a single variety under the one name, but it nevertheless exhibits considerable variation in both tree and fruit characters.

In the course of an extensive study of bud variation in tree fruits in Michigan, many Montmorency orchards were visited and tree, flower and fruit differences were noted. In all, 301 individual trees or branches (bud sports) were found that presented some peculiarity of appearance or behavior that seemed to set them apart as more or less distinct strains. These were rechecked another year and in many instances year after year for a considerable period to learn whether the difference noted was permanent or something due to a temporary environmental influence. One hundred and sixty-six of these variant forms that appeared to be more or less permanent were propagated and the trees grown to fruiting age (some were kept in the orchard for 16 years). At the same time, a considerable number of trees were propagated and grown of the parent or normal form of the variety to serve as checks on the variants. In due course of time, suitable records were made of the vegetative, flower, and fruit characteristics and the yields of the daughter trees.

Many of the differences noted in the original variant trees or limbs appeared in the daughter trees; others did not. The records showed clearly, however, that there is not only great tree-to-tree and limb-to-

ARTICLE 31-11

limb diversity in the Montmorency cherry, but that many of these variants are of the nature of intra-variety strains. How much of a deviation from type is necessary before it can be classified as a strain is of course a matter of judgment. Some qualified individuals after carefully studying the Experiment Station's collection of Montmorency forms might say that it included upwards of 100 distinct strains; others equally well qualified might put the number at less than 10. There are, for instance, several petal-less forms that are otherwise entirely normal for the variety in tree and fruit characters. Obviously they would not be recognized as distinct strains unless seen at blossoming time. There are forms with distinctly cordate fruits. Probably fewer would be inclined to consider this feature worthy of recognition as a character identifying a distinct strain than they would a comparable difference in fruit size, maturing season or tree productivity. A difference of 10 days or 2 weeks in maturing season would much more probably be recognized as characterizing a distinct strain than would a consistent difference of 5 to 7 days.

In the study of intra-variety variation in the Montmorency cherry at the Michigan Station, no attempt has been made to appraise the variants from the standpoint of which ones may and which may not be entitled to strain rank. The effort has been, rather, to study: 1) the nature of the differences, 2) their permanence or fixity as influenced by seasonal and other environmental conditions and 3) as evidenced by the performance of daughter trees propagated from them, and finally 4) to appraise them from the viewpoint of possible commercial value. In attempting to evaluate them on the basis of their possible use to the producer, they may be arbitrarily grouped according to certain features or characteristics, as follows:

Healthy or virus (yellow leaf)—infected.
Relatively vigorous or relatively weak.
Relatively productive or relatively unproductive.
Fruits relatively large or fruits relatively small.
Fruit normal in maturing season or late in maturing.
Aberrant form (e.g., with long-stemmed fruits).

Healthy and Virus-infected Strains—When the collection of Montmorency cherry strains was begun in the twenties, the yellow leaf virus or yellows disease was not recognized as a disease. It was, nevertheless, present, and a number of the early "strains" that were collected were infected with the disease. Indeed one of them was

described and propagated as a "yellow leaf" strain. The virus-infected strains have, of course, remained infected. Furthermore, individual trees of some of the strains free from the virus at the time they were planted have become infected. Others have remained free, though grown in close proximity to infected stock. Thus there has been the opportunity to compare virus-infected with healthy strains as well as different healthy strains with each other.

In general, infection with the virus has resulted in a distinct dwarfing of the trees and a marked reduction in productivity over and above that which would be associated with the difference in tree size. Thus in 1940, after 6 years in the orchard (8 years after the buds were set in the nursery row), 94 virus-free trees of 23 different Montmorency selections or strains had an average trunk circumference of 7.2 inches; 107 virus-infected trees of 24 selections or strains had an average trunk circumference of 5.5 inches. The average yield per tree per season of 68 virus-free trees of 15 different strains for the 1939-1941 seasons (trees planted in the spring of 1934) was 11.9 pounds; the average yield per tree per season of 68 virus-infected trees of 17 different strains for the same seasons, planted at the same time and grown under strictly comparable conditions, was 6.1 pounds.

There were substantial differences in both growth and yield of different groups (strains) of virus-infected trees. Thus trees of Strain 178 averaged 10.2 pounds yearly during the 1939-41 seasons as 5- to 7-year-olds, while trees of Strain 351 under strictly comparable conditions averaged only 1.9 pounds. Later performances of the same groups of trees have been consistent with their 1939-41 records. This suggests two possibilities: 1) that there are different strains of the virus, some of which are far more virulent than others, or 2) that there are strain differences within the Montmorency variety differing markedly in their degree of resistance or susceptibility to the disease, or perhaps more accurately, to its weakening effects. One instance in the records of the Experiment Station indicates rather clearly that there are strain differences in resistance to the disease, though it does not preclude the possibility of there being different strains of the virus. Bud wood for propagating strains 262 and 263 was obtained at the same time from different parts of the same tree. The parent branch for Strain 262 was distinctly weak and unproductive; the rest of the tree, one of whose branches furnished bud wood for Strain 263, was far from being vigorous and productive, but it was more vigorous and more productive than Branch 262. All of the daughter

trees of Strain 263 were *semi-dwarf,* those of Strain 262 were *dwarf.* Their average yearly yields per tree for the 1939-41 period were 6.6 and 2.5 pounds, respectively. The parent tree and all of its daughter trees were virus-infected; the different branches of the parent tree and likewise their daughters presumably were infected with the same strain of the disease.

Strain 178 has been grown in several different blocks planted at different times and places on the Experiment Station grounds. There is no question about all of them being virus-infected, but this strain has been consistently a fairly good performer in the orchard, better than some of the virus-free but rather weak strains. Its performance and that of several others infected with the virus suggests the practicability of selecting and growing strains that are able to tolerate the disease and still thrive rather than attempting to keep healthy, but virus-susceptible, stocks free from the disease by continuous roguing.

Vigorous and Weak Virus-free Strains — In an earlier publication of the Michigan Station,[1] data were presented showing that there are differences in size and vigor of certain Montmorency cherry trees having no evidence of virus-infection that are transmitted to their vegetative offspring. In other words, there are intra-variety strains with differences in tree size and vigor. These differences in size of tree may be of such a magnitude as 3 to 2 or even 2 to 1. The records of the Michigan Experiment Station show clearly that there are equally great differences in strain performance, as measured by tree yield. For instance, the average annual yield of 5- to 7-year-old trees of Strain 450 during the 1939-41 period was 8.0 pounds, that of Strain 468 was 9.9 pounds; during the same period and under the same conditions the average yields of strains 264 and 516 were 15.2 and 17.6 pounds, respectively. Not every tree bearing a relatively heavy crop in one particular season will each and every year outbear the surrounding trees in an orchard. Heavy production one year may be followed by a lighter crop the next season, as is often true of apples. If, on the other hand, over a considerable period of years the average yields of a group of trees of one vegetative parentage are substantially greater or less than those of another group of another parentage, it is evidence of a genuine strain difference.

[1]Studies in the Nature of the Clonal Variety. III. Permanence of Strain and Other Differences in the Montmorency Cherry—Gardner, V. R.—Mich. Agr. Exp. Sta. Tech. Bul. 186. 1943.

Large-fruited and Small-fruited Strains — Size of fruit borne by different trees in any one season can be readily measured. Determination of differences in fruit size between two or more strains is more difficult. Size of fruit is greatly influenced by the relative size of the crop that is borne, not only by the tree as a whole, but by individual branches, by abundance of foliage, by localized variations in soil depth and condition, by the kind and amount of spray materials used, and by many other factors. After due evaluation of all such factors, however, the records obtained at the Michigan Station over a period of 20 years show clearly that some strains of the Montmorency cherry consistently bear rather large fruits while others bear relatively small ones. For instance, in 1936, the average weights of individual fruits from four trees of Strain 150 ranged from 2.67 to 3.08 grams, with a mean of 2.84; under the same conditions, individual fruits of four trees of Strain 168 ranged from 2.02 to 2.70 grams, with a mean of 2.34. In view of the fact that the crops borne by the two groups of trees were comparable and the difference seemed to be consistent year after year, it is believed that these two selections represent a true strain difference in respect to fruit size. Though not striking, it is great enough to be of commercial importance. A more striking difference in fruit size is presented by the records of selections 481 and 482. Selection 481 was propagated as a "normal" Montmorency, as a check against a small-fruited, early-maturing limb variant. In 1936, the mean weight of 3,528 fruits harvested as a random sample of Selection 481 was 2.378 grams while that of a random sample of 9,856 fruits from its limb sport was 1.584 grams; this was in spite of the fact that the limb sport was less heavily loaded than the parent form. Daughter trees of these two forms in later years consistently produced fruits that showed a similar difference in size.

Strains Differing in Maturing Season — Some strain differences in maturing season are almost as difficult to recognize and evaluate as are strain differences in fruit size, for maturity is delayed by heavy cropping and defoliation due to leaf spot, spray injury, winter injury of the blackheart type, and other factors. On the other hand, many striking instances of early or late maturity, differences of a week or more, are readily recognized. In the course of the bud-sport studies at the Michigan Station, a few early-maturing and many late-maturing strains have been found and propagated. Both early-maturing and late-maturing strains that are practically identical with the nor-

mal parent form in other respects would be welcome additions to the variety and strain list, for they would extend the harvesting season. In the course of the studies at the Michigan Station, practically all of the late-maturing strains have been found to be less productive than the normal form, or to ripen their fruits unevenly, and the few early-maturing strains have not been enough earlier to make them of great value.

Aberrant Forms — Incident to this study, many aberrant forms have been found and some of them have been propagated and carefully studied. These include long-stemmed strains, strains with small-petaled or petal-less flowers, those whose fruits are heart-shaped or with deep sutures, barren or semi-barren strains, etc. Some of these are very interesting forms, but few, if any, promise to be of any commercial value.

Superior Strains

No commercial producer would knowingly set virus-infected trees; nor would he deliberately set trees that he knew would be below average in vigor and productivity, or that were uneven in ripening season. Certainly he would not plant any aberrant forms.

The ideal strain from the standpoint of the producer is, among other things, one that is both virus-free and virus-resistant or that will tolerate infection and still thrive; it should grow vigorously and make a large tree; it should blossom relatively late and its flower buds and flowers should be resistant to frost; its blossoms should "set" well; it should be very productive; its foliage should be resistant to leaf spot and to spray injury; its fruits should be large and mature evenly.

No strain has been found that possesses all these requirements to the desired degree. Several have been found and tested over a period of years and found to be *relatively* good. This does not mean that they are resistant to the yellow leaf virus; whether they are is unknown at the present time, for they have not been evaluated in this respect by inoculation tests. However, the stocks of them in the Station's plantings have thus far remained virus-free. They are vigorous, thrifty growers and relatively heavy producers of fruits medium to above medium in size. Bud wood of these strains certified as virus-free by the inspection service of the Michigan State Department of Agriculture after suitable "indexing" tests, has been made available

to nurseries requesting it, and stock of them is being propagated and sold by the nurseries. It should be pointed out that there is no guarantee that trees of any one of these strains may not become infected with the yellow leaf virus after the buds have been set in the nursery row or after the trees have been planted in the orchard, if there are near-by sources of infection. Brief descriptions of four strains that have thus far been released to the nursery trade follow.

Strain 264 is simply to be regarded as a good strain of Montmorency, normal in its various characters. The parent tree grew in an orchard near Mears in Oceana County, Michigan. Though rather unfavorably located, this tree had a good production record. Daughter trees on the Experiment Station grounds have been large, vigorous, productive, and have been virus-free. Their fruit has been of good size and has ripened evenly. Yields per tree per year during the 1939-41 period, as 5- to 7-year-olds, averaged 15.2 pounds, compared with 11.9 pounds for 15 virus-free strains.

Strain 297 was propagated from a tree in the Traverse City area that was known to have borne heavy corps year after year for many years. Its daughter trees in the Michigan Station's orchard are especially thrifty, vigorous growers. Their average yield per tree per year during the 1939-41 period was 12.4 pounds, again compared with 11.9 pounds for 15 virus-free strains.

Strain 465 was propagated from an exceptionally large vigorous tree in an orchard near South Haven, Michigan. The yields of its daughter trees in the Station's test have been only slightly above the average for other virus-free strains. It is probably not an exceptional, but it is a good, strain.

Strain 516 was propagated from what originally was taken to be a productive limb sport in a tree in the same orchard from which Strain 465 came. Yearly checks on the performance of the parent limb with that of the remainder of the tree indicated that it was an exceptionally heavy producer. This heavy production was due to a slight but consistent difference in susceptibility of the flower buds to killing by low temperature while in a swollen or "delayed dormant" stage in the spring and to rather marked and consistent difference in percentage of blossoms that set and matured fruit. Some of the records obtained on the performance of this limb sport (Selection 516) and the rest of the same tree (Selection 517), which may be regarded as a normal Montmorency, are interesting. On April 25 and 26, 1933,

frosts resulted in considerable killing of unopened buds in this orchard; 68 percent of the individual flower buds were killed on Branch 516, 87 percent on 517. There was no corresponding injury in 1934, but in 1935 there was considerable delayed dormant killing of flower buds. It amounted to 41 percent on Branch 516, 48 percent on 517. On April 22, 1938, the temperature fell to 22° F. at the Graham Station where young trees of both these strains were growing. Seventy-one percent of the flower buds were killed on Strain 516, 79 percent on Strain 517. The differences in bud hardiness were small but consistent from year to year. In 1933, when neither the parent limb sport 516 nor the rest of the tree, 517, bore heavy crops, the percentages of flowers that set and matured fruits were 9 and 1.4, respectively. In 1934, when Branch 516 bore a heavy crop and 517 bore a light one, fruit setting on the two parts as determined from counts of large random samples was 35 and 8 percent, respectively. In 1935 the corresponding percentages were 27 and 6. In 1936 they were 14 and 5. On the other hand, in 1937 when conditions were very favorable for fruit setting, daughter trees of both strains at the Graham Station set exceptionally high percentages, 49 and 62, respectively, Strain 517 exceeding 516. Average annual yields per tree per year of the two strains for the 4-year period 1939-42 were 19.5 and 14.4 pounds, respectively, on trees of essentially the same size. This rather long series of records leaves little doubt that 516 is an excellent strain.

No claim is made that any one of these strains is the best that can be found or even that they are better than others being propagated. They are simply good strains, though probably they are better than stock propagated without any selection. However, there is every reason to believe that equally good, possibly better, strains may be found in many producing orchards. Whether any particular strain is inferior, superior, or just average can be determined only by careful tests.

HEALTH AND HEALTH SERVICES IN THREE MICHIGAN COMMUNITIES

By CHARLES R. HOFFER[1]
SECTION OF SOCIOLOGY AND ANTHROPOLOGY

COMMUNITIES do not have a full or equal measure of facilities or services to maintain health. The factors which affect it are too numerous and variable for such a condition to prevail. Age composition of the population, economic status, and health practices of families are important influences in this connection. Also, health services such as medical doctors, hospitals and public health activities do not exist uniformly among all communities.

The extent of good health or the opposite, ill health, is not definitely known in either rural or urban communities. Statistics concerning health and health care are usually compiled on a county and state-wide basis and pertain to specific diseases or to specific health practices. They do not relate to local communities as ecological and social units nor do they indicate the amount of unsatisfied need which the people in any particular community may have.

The purpose of this article is to examine the problem of health and health care in the community, that is, the population of a town and its adjacent rural trade area. The specific purposes of the study are as follows:

1. To ascertain the extent of ill health as indicated by need for medical attention in each community.

2. To determine relationship between ill health and certain socio-economic factors such as income and place of residence.

3. To determine the extent to which residents of the respective communities use available medical services and the opinions they have concerning such services.

[1]This study was made in cooperation with the Community School Service Program of the Michigan State Department of Public Instruction. Dr. Edgar A. Schuler, Dr. J. F. Thaden, and Dr. Duane L. Gibson of the Social Research Service assisted in planning and carrying out the detailed activities of the project apart from family interviewing. The interviewing was done by Mr. Linwood Hodgdon, a graduate student at Michigan State College, his wife, Candis Hodgdon, R.N., and the author of this article.

ARTICLE 31-12

THE COMMUNITIES SELECTED FOR STUDY

Three town-country communities in Michigan were selected for the study. Included in this sample were Mesick (Wexford County) in the northern part of the lower peninsula, Stephenson (Menominee County) in the extreme southwestern part of the upper peninsula and Concord (Jackson County) in the central part of the lower peninsula.

Mesick is a small town having a population of 337. The town and its trade area include a total population of about 1,500. The population of Stephenson is 612 and that of a smaller town, Daggett, near Stephenson is 283. The population of its trade area is estimated to be 5,950. The total population of that community would thus be 6,845, or approximately 7,000 persons. The United States Census reports a population of 618 for Concord in 1940. Its trade area has an additional population of 1,134. Hence its total population is 1,752.

At the time the study was made, Stephenson and Concord had one or more medical doctors who practiced in their respective communities, but in Mesick the only doctor was an elderly man who had retired from active practice. None of the communities had a hospital, but hospitals did exist in adjoining communities within a distance of 25 miles. Concord and Stephenson each had a dentist. This service was not available in Mesick.

METHOD OF STUDY

The survey method was used to obtain data from a fairly random sample of families in each of the three communities. To acquire information about the health status and the need for medical attention among the people the "symptoms approach" technique was used. This technique consists of questioning informants concerning 27 symptoms which are included as part of the survey schedule. They are the kind of symptoms a physician usually looks for when taking a medical history. In the opinion of medical doctors who cooperated in making the list, every symptom, if present, constitutes a medical need at least to the extent that the advice of a doctor should be sought regarding the matter.[2] The remaining parts of the

[2]This list of symptoms had been previously validated by having a random sample from 306 Michigan farm families for whom data had been obtained receive a medical examination. There was an agreement between the schedule data and the medical examination regarding the need for medical attention in 8 out of 10 cases. A detailed account of the experiment is presented in Journal Article No. 864 (n. s.), Michigan Agricultural Experiment Station, Charles R. Hoffer and Edgar A. Schuler, Michigan State College, in cooperation with Rosalie Neligh, M.D., and Thomas Robinson, M.D., University of Michigan Medical School, "Determination of Unmet Need for Medical Attention Among Michigan Farm Families," *The Journal of the Michigan State Medical Society, 46:* 443-46, April 1947.

schedule contained questions about the use families made of medical and hospital services, the attitudes they had regarding medical service in their respective communities and certain facts of a socio-economic nature about each family.

A total of 433 families were included in the survey. In Concord 51 families in the town and 53 in the country were interviewed. These were selected in a random fashion so that 1 family in each 4 was contacted in the town and 1 family in each 6 in the country. Of the 118 families in the Stephenson community, 53 lived in town and 65 in the open country. Here 1 family in each 6 in the town and 1 in each 25 in the open country provided the information. In Mesick, all town families, a total of 112, were interviewed, while 99, or one-third, of those in the country constituted the sample. In Mesick the field work was done in December 1946. In Stephenson and Concord this part of the study was completed in June and July 1947.

EXTENT OF NEED FOR MEDICAL CARE

A basic assumption in the study was the idea that any one of the 27 symptoms, if reported to be positive, would constitute a need for medical attention at least to the point of diagnosis and possible treatment. If a medical doctor had not been consulted about a positive symptom it was considered as an unmet medical need.

The proportion of individuals in the various communities that had one or more unmet medical needs is shown in Table 1.

By totaling the percentages in rows c, d and e in Table 1, it is evident that 40.4 percent of the individuals in the sample population residing in the open country had one or more unmet medical needs (as defined in the purposes of the study), and that the corresponding percentage for town residents was 28.5 percent. Equally important from the standpoint of community organization is the fact that in each of the three communities the percentage of unmet need for medical care was higher in the open country than it was in the town. The difference between the town and country residents in Concord was 15 percent and in Stephenson 14.4 percent. In Mesick the difference was only 11 percent, probably because medical services were lacking for both town and country groups. Likewise, the percentage of the population that had no positive symptoms or had all positive symptoms treated by a medical doctor (rows a and b in Table 1)

TABLE 1—*Percentage distribution of individuals in three Michigan communities by specified individual level of health and health care, 1947**

Level of health and health care	Concord		Stephenson		Mesick		Total for the three communities	
	Town	Country	Town	Country	Town	Country	Town	Country
Totals: Number	148	189	190	238	355	377	693	804
Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
No unmet need Higher level								
a. No positive symptoms	65.0	54.0	56.9	53.5	44.0	39.0	52.0	47.7
b. One or more positive symptoms treated by M.D	22.0	18.0	23.7	13.0	16.0	10.0	19.5	12.9
One or more unmet needs Lower level								
One or more positive symptoms untreated by M.D.								
c. Some positive symptoms untreated, others treated by M.D	2.0	8.0	7.4	7.7	12.0	12.0	8.5	9.7
d. Some positive symptoms untreated, others treated by non-medical practitioner, others treated by M.D	6.0	2.0	1.0	**	1.0	2.0	2.0	1.6
e. All symptoms untreated or treated by home remedies only	5.0	18.0	11.0	25.8	27.0	37.0	18.0	29.1

*Individual level of health and health care is determined by type of medical care received when one or more positive symptoms is reported for an individual. Four individuals in the total of 1501 were not included in the calculations of this table.

**Less than one-tenth of one percent.

was higher in the town than in the open country in each community. The difference in favor of town residents was 15 percent in Concord, 14.1 percent in Stephenson and 11 percent in Mesick.

AN ESTIMATE OF THE NEED FOR MEDICAL ATTENTION IN EACH COMMUNITY

With the percentage listed in Table 1 as a basis, it is possible to calculate, within the limits of statistical variation due to sampling, the total need for medical care in each community. In Concord one family in each four in the town and one in each six in the trade area were interviewed. Among these sample families, 52 persons in town and 88 in the country had need for medical care during the 6-month period preceding the interview. Consequently, if the number of

town residents be multiplied by 4 and that for the country by 6 it follows that a total of 736 persons (42.2 percent of the total population) in the community had need for medical attention. Following a similar method of computation, but using only the number of individuals who had one or more unmet medical needs, it becomes evident that 396 persons (22.4 percent of estimated population) in the community had unmet medical needs in the 6-month period preceding the survey.

In Stephenson, where 1 family in each 6 in the town and 1 family in each 25 in the country were interviewed, similar calculations showed that 3,267 persons, 47.9 percent of the total estimated population, had need for medical attention. The percentage of the total estimated population having one or more unmet medical needs was 32.2 percent. In Mesick, which was less well provided with medical service than the other communities at the time of the survey, 88 percent of the estimated population had need for medical attention during the period of 6 months preceding the interview, and 82.2 percent of the population had unmet medical needs, as indicated by the list of symptoms used in this survey.

PREVALENCE OF SYMPTOMS DENOTING NEED FOR MEDICAL ATTENTION

As explained in the preceding section a total of 27 symptoms was used to determine the extent of medical need for each individual. It is of interest to note the distribution of the frequency of occurrence of the symptoms among the persons included in the survey. The data pertaining to this matter appear in Table 2. They indicate that certain symptoms, such as poor vision, persistent pains in the joints, persistent backache and severe shortness of breath after doing light work, are the most prevalent. These symptoms are chronic in nature and hence the individual "lives with them," so to speak. It does not follow, however, that they are unimportant, because such symptoms may still cause discomfort and reduce the efficiency of the individual. In fact, all of the symptoms, even those which occur infrequently, are significant for the individual's health and well-being. According to the opinion of medical doctors who help select the list, any symptom, if neglected, may be a hazard to the health of the individual.

The methods used to treat the various symptoms are shown by

TABLE 2—*Number and percent of persons in each community reporting designated symptoms within a period of 6 months preceding the survey, 1947*

Symptom	Concord (337 persons in sample)		Stephenson (428 persons in sample)		Mesick (736 persons in sample)		Total for three communities 1501	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Poor vision for distant or close work, e.g., reading	28	8.3	39	9.1	91	12.4	158	10.5
Persistent pains in joints	20	5.9	39	9.1	88	12.0	147	9.8
Toothache	24	7.1	31	7.2	56	7.6	111	7.4
Repeated or persistent backache	20	5.9	21	4.9	69	9.4	110	7.3
Severe shortness of breath, after doing light work	20	5.9	19	4.4	65	8.8	104	6.9
Unable to chew food: teeth "sore" or missing	19	5.6	17	4.0	60	8.2	96	6.4
Persistent headaches	17	5.0	17	4.0	61	8.3	95	6.3
Unexplained tiredness: regularly	8	2.4	21	4.9	63	8.6	92	6.1
"Rupture", hernia or wearing of truss	14	4.6	19	4.4	49	6.7	82	5.5
Repeated or prolonged pains in the stomach or anywhere in the abdomen	21	6.2	12	2.8	44	6.0	77	5.1
Persistent skin rashes or itching of skin: "breaking out" (one week or more)	8	2.4	18	4.2	43	5.8	69	4.6
Accidental injuries: broken bones, head or severe injuries, accidental poisoning, snake bites, etc	5	1.5	12	2.8	40	5.4	57	3.8
Persistent cough (except colds in chest)	7	2.1	4	0.9	40	5.4	51	3.4
Continued loss of appetite	11	3.3	9	2.1	28	3.8	48	3.2
Repeated or persistent swelling of ankles (two weeks or more)	12	3.6	4	0.9	26	3.5	42	2.8
Asthma or hay fever	8	2.4	4	0.9	27	3.7	39	2.6
Sore mouth: due to plates or bridges	6	1.8	13	3.0	18	2.4	37	2.5
Persistent pains in chest	6	1.8	8	1.9	23	3.1	37	2.5
Unexplained loss of weight: persons over 18: 10 pounds or more in past 6 months. Persons under 18: any unexplained loss of weight	4	1.2	7	1.6	26	3.5	37	2.5
Repeated or frequent bleeding gums	7	2.1	3	0.7	26	3.5	36	2.4
Repeated nosebleeds not due to blow or injury	3	0.9	9	2.1	23	3.1	35	2.3
Fainting spells: stuttering, stammering, nervous breakdown, fits, convulsions	9	2.7	5	1.2	12	1.6	26	1.7
Lumps or discolored patches on skin	2	0.6	3	0.7	17	2.3	22	1.5
Running ear or ears: watery, bloody, pus	1	0.3	10	2.3	11	1.5	22	1.5
Coughing or spitting blood	9	2.7	1	0.2	5	0.7	15	1.0
Open or running sores that do not heal: leg or foot ulcers, others	3	0.9	1	0.2	11	1.5	15	1.0
Repeated vomiting: (several days or more)	4	1.2	3	0.7	7	1.0	14	0.9

TABLE 3—*Number and percent of individuals reporting positive symptoms who used designated methods of treatment*

Symptom	Number of persons reporting symptoms	Method of treatment: No treatment or home remedy only — Number	Percent	Non-M. D. — Number	Percent	M. D. (or dentist) — Number	Percent
Poor vision for distant or close work, e.g., reading	158	111	70.3	1	0.6	46	29.1
Persistent pains in joints	147	87	59.2	6	4 1	54	36.7
Toothache	111	67	60.4	0	—	44	39.6
Repeated or persistent backache	110	52	47.3	12	10.9	46	41.8
Severe shortness of breath: after doing light work	104	53	51.0	3	2.9	48	46.2
Unable to chew food: teeth "sore" or missing	96	80	83.3	2	2 1	14	14.6
Persistent headache	95	60	63.2	4	4.2	31	32.6
Unexplained tiredness: regularly	92	45	48.9	3	3 3	44	47.8
"Rupture", hernia or wearing of truss	82	43	52.4	1	1.2	38	46.3
Repeated or prolonged pains in stomach or anywhere in abdomen	77	33	42.9	3	3.9	41	53.2
Persistent skin rashes or itching of skin, "breaking out" (one week or more)	69	20	29.0	4	5 8	45	65.2
Accidental injuries: broken bones, head or severe injuries, accidental poisoning, snake bites, etc	57	12	21.1	4	7.0	41	71.9
Persistent cough (except colds in chest)	51	27	52.9	3	5.9	21	41.2
Continued loss of appetite	48	21	43.8	3	6 3	24	50.0
Swelling of ankles (two weeks or more)	42	23	54.8	1	2.4	18	42.9
Asthma or hay fever	39	17	43.6	2	5.1	20	51.3
Sore mouth: due to plates or bridges	37	31	83.8	0	—	6	16.2
Persistent pains in chest	37	15	40.5	3	8.1	19	51.4
Unexplained loss of weight. Persons over 18: 10 pounds or more in past 6 months. Persons under 18, any unexplained loss of weight	37	14	37.8	1	2.7	22	59.5
Repeated or frequent bleeding of gums	36	27	75.0	0	—	9	25.0
Repeated nosebleeds not due to blow or injury	35	24	68.6	0	—	11	31.4
Fainting spells: stuttering, stammering, nervous breakdown, fits, convulsions	26	12	46.2	4	15.4	10	38.5
Lumps or discolored patches on skin	22	17	77.3	0	—	5	22.7
Running ear or ears: watery, bloody, pus	22	10	45.5	0	—	12	54.4
Coughing or spitting blood	15	9	60.0	0	—	6	40.0
Open or running sores that do not heal: leg or foot ulcers; others	15	5	33.3	0	—	10	66.7
Repeated vomiting (several days or more)	14	4	28.6	0	—	10	71.4

the figures in Table 3. They indicate that "no treatment" or "home remedies only" are reported one or more times for every symptom, but this method was used more frequently for ailments which were chronic in nature. On the other hand, treatment by a medical doctor (or dentist for dental problems) was reported one or more times for every symptom.

It is obvious, therefore, that the standards of medical care varied among these families though the unavailability of medical service or lack of funds to pay for it may have prevented some individuals from receiving medical attention. Figure 1 shows the percentage of the sample population having positive symptoms and the percentage whose positive symptoms were untreated.

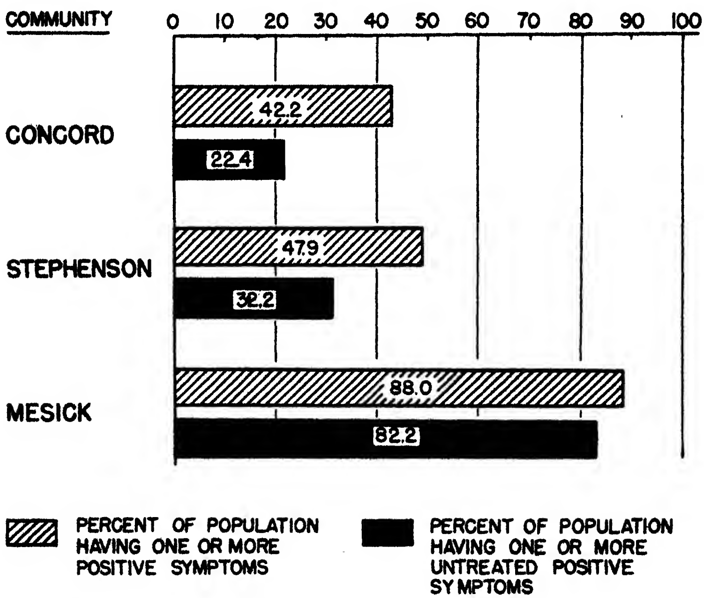

Fig. 1. The percentage of the estimated population in each community having medical needs (one or more positive symptoms) and the percentage having unmet medical needs (one or more positive symptoms untreated). The ratio of unmet needs to total needs provides an index of completeness of medical care in each community. In Concord this ratio was 0.53, in Stephenson 0.66, and in Mesick 0.93. The ratio decreases as the percentage of positive symptoms treated by a physician increases.

TABLE 4—*Number of individuals in each community losing designated number of days of work on account of illness during the 6-month period preceding the survey*

Days from work	Community						Three communities	
	Concord		Stephenson		Mesick			
	Number of individuals	Percent of total in survey	Number of individuals	Percent of total in survey	Number of individuals	Percent of total in survey	Number of individuals	Percent of total in survey
None	273	81	344	80.5	578	78.5	1195	79.7
1 – 9	35	10	49	11.4	79	10.7	163	10.9
10 – 19	13	3	16	3.7	31	4.2	60	4.0
20 – 29	2	1	3	.7	10	1.4	15	1.0
30 – 59	9	3	9	2.1	10	1.4	28	1.9
60 and over	5	2	7	1.6	26	3.5	38	2.5

DAYS LOST FROM WORK ON ACCOUNT OF ILLNESS

An indication of the seriousness of ill health from the standpoint of efficiency is made evident by the number of individuals who lost 1 or more days' work on account of illness. The extent of this loss for a period of 6 months in each of the three communities and for the total is shown in Table 4.

FACTORS ASSOCIATED WITH NEED FOR MEDICAL CARE

Age: It has been observed many times that as a population advances in age the number of ailments which create the necessity for medical attention increases. The population in the three communities under consideration seems to demonstate again this relationship. As a population becomes older, the positive symptoms become

TABLE 5—*Average number of positive symptoms per individual in the various age groups included in the sample for each of the three communities*

Age	Concord		Stephenson		Mesick		Total	
	Number of persons	Average number of symptoms	Number of persons	Average number of symptoms	Number of persons	Average number of symptoms	Number of individuals	Average number of symptoms
Under 10	64	.11	52	.27	158	.44	274	.33
10 – 19	55	.44	38	.50	125	.67	218	.58
20 – 29	38	.63	25	.40	66	1.27	129	.91
30 – 39	40	.80	39	.87	96	1.24	175	1.06
40 – 49	36	.94	21	1.14	66	1.62	123	1.34
50 – 59	40	1.40	20	1.85	84	2.00	144	1.81
60 – 69	33	1.70	28	1.50	85	3.08	146	2.47
70 and over	31	1.68	10	1.10	38	2.42	79	1.96
Not reported	—	—	5	—	18	—	23	—

TABLE 6—*Number and percent of individuals in designated income groups reporting one or more positive symptoms*

Gross cash income (1947)	Concord			Stephenson		
	Number of individuals	Percent having 1 or more positive symptoms	Percent of those having symptoms who were treated by an M. D.	Number of individuals	Percent having 1 or more positive symptoms	Percent of those having symptoms who were treated by an M. D.
Under $1000....	49	59	34	69	62	25
$1000–$2000....	81	49	55	165	43	43
$2000–$3000....	102	31	44	126	40	52
Over $3000....	93	37	58	51	37	53
Not Reported..	12	—	—	17	—	—

more numerous. The increase is especially evident after the age period 50-59 is reached. The detailed figures are presented in Table 5.

Gross Income: Families with low incomes generally have more illnesses and less medical care than those in the higher income brackets. Tabulations were made to ascertain whether there was evidence of these relationships among the families in the communities under consideration. The essential data are presented in Table 6.[3] The figures show that, in general, as the gross cash income increases, the proportion of individuals having positive symptoms decreases. Also, among those reporting positive symptoms, the percentage whose symptoms were treated by a medical doctor increases as the income rises.

Housing Facilities and Need for Medical Care: Tabulations using the family as the unit were made to determine what relationship existed between certain housing facilities and need for medical care. The data for families in the three communities combined are presented in Table 7. Again the expected relationship appears. There is more need for medical attention among families who do not have running water and inside toilets than there is among families whose houses are provided with these facilities. The percentages for no positive symptoms and one or more positive symptoms each treated by a medical doctor were tested by a statistical formula to find out if the differences between the percentages for those having a housing facility and those not having it were due to chance. The results showed that the differences were greater than could be attributed to chance only.

[3]Only data for Concord and Stephenson are included in this table. Corresponding tabulations were not made for Mesick. A tabulation of data for Mesick using the family instead of the individual as the unit showed similar relationships.

TABLE 7—*Need for medical care among families having designated housing facilities*

Housing facilities	Families reporting		No positive symptoms, percent	One or more positive symptoms treated by M. D., percent	Some positive symptoms untreated, others treated by M. D., percent	Some positive symptoms untreated, others treated by non-medical practitioner, others by M. D., percent	All symptoms untreated or treated by home remedies only, percent
	Number	Percent					
Have running water	124	100	22	32	27	6	13
Do not have running water	98	100	12	27	30	7	24
Have inside toilet	94	100	24	31	27	7	11
Do not have inside toilet	128	100	14	28	30	5	23

HEALTH SERVICES

Medical Services: At the time the survey was made, the Concord community had one medical doctor and one dentist. Also, one osteopathic doctor was practicing there. The estimated population of the community was 1,752. This is a large number for one medical doctor. One doctor for a population of 1,000 is usually considered to be a reasonable number. All of the larger communities, however, which were 20 to 25 miles from Concord, had medical doctors and some of the families in Concord went to Jackson, Albion, or elsewhere for medical service.

In the Stephenson area, there were four medical doctors—two in the town of Stephenson and two in Daggett near Stephenson. One of the four was an elderly man who had reached a retirement status. Since the estimated population of the area is 7,000, it is obvious that there are approximately 2,300 persons per active physician. There were no osteopathic physicians in the area. Only a few of the families living in the outlying parts of the area went to doctors in other communities. There was one dentist in the area.

Medical service in the Mesick community was even less satisfactory. The estimated population of the community was about 1,500. The only doctor in Mesick was an elderly man who had retired. Though he practiced as much as he could, residents of that community had to go elsewhere for most of the medical care they received. The community did not have a dentist.

TABLE 8—*Distance to a medical doctor for families living in the open country in each of the communities surveyed*

Miles	Concord		Stephenson		Mesick	
	Number	Percent	Number	Percent	Number	Percent
0– 9	65	100	44	68	128	61
10–19	0	0	17	26	73	35
20–29	0	0	4	6	9	4
30–39	0	0	0	0	1	(–)*

*Less than 1 percent.

Distance to a Doctor's Office: One indication of medical service for a rural family is distance to a doctor's office. This factor for the three communities under consideration is shown in Table 8.

It appears from the figures in Table 8 that a majority of the families lived less than 10 miles from a doctor's office. In these days, when the use of the automobile is so general, such a distance would seem not to be excessive. About a third of the families in the Mesick community and one-fourth of those in the Stephenson area were 10-19 miles from a doctor's office. A total of 14 families were more than 20 miles from this service. Only in the Mesick community, however, was it necessary for a family to go to a town other than their regular trade center to see a doctor.

Inquiry was made to determine the proportion of families having what they considered a family doctor. In Concord this kind of relationship was most general, because 91 percent of the 104 families reported a family doctor. In Stephenson the corresponding percentage for 118 families was 86.4. In Mesick, where 211 families resided, it was 77.8.

Regardless of what a family may choose to do or how far it may live from a doctor's office, occasions will arise when it is necessary to see a doctor. Therefore, inquiry was made regarding the use of medical service by the families included in this survey. In each instance the family was asked how long it had been since any member had consulted their family physician. The results of this inquiry are presented in Table 9.

The figures in Table 9 clearly indicate that most of the families did find it necessary or advisable to consult a doctor within less than 1 year from the time of the survey. On the other hand, a few, either

TABLE 9—*Length of time since one or more members of the family consulted their family physician*

	Concord community		Stephenson area		Mesick community	
	Number	Percent	Number	Percent	Number*	Percent
TOTAL	96	100	102	100	211	100
Less than 1 year	83	87	64	64	98	47
1 – 2 years	7	7	20	20	12	5
2 – 3 years	2	2	6	5	4	2
3 – 4 years	0	0	5	5	2	1
4 years and over	2	2	6	5	95	45
Not reported	2	2	1	1	—	—

*Doctors in addition to family doctor were included.

because of neglect or good luck, got along for several years without having any of their members see a doctor.

The second approach in obtaining a measure of use of medical service was to ask how many times each member of the family had consulted a doctor in the 6-month period preceding the survey. This information was obtained for a total of 765 individuals in the Concord and Stephenson communities[4] and is presented in Table 10. The figures make it clear that about two-fifths of the 765 individuals in the sample consulted a doctor at least one time during the period of 6 months. Ninety individuals had consulted a doctor five or more times.

TABLE 10—*Number of times residents in the Concord and Stephenson areas visited a doctor in 6 months preceding survey*

Number of times a doctor was consulted	Concord				Stephenson				Both communities	
	Open country residents		Town residents		Open country residents		Town residents		All residents	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
None	117	62	77	52	182	76	98	52	474	62.0
1	28	38	27	18	15	6	41	22	111	14.5
2	14	15	7	5	14	6	17	9	52	6.8
3	4	2	6	4	9	4	8	4	27	3.5
4	3	2	3	2	2	1	3	2	11	1.4
5 or more	23	22	28	19	16	7	23	12	90	11.8

[4]The question about number of times each member of the family had consulted a doctor during the period of 6 months preceding the survey was not asked of families in the Mesick community.

OPINIONS OF INFORMANTS ABOUT MEDICAL SERVICES IN THEIR COMMUNITIES

Opinions of the informants regarding medical services available to them were ascertained by asking the question: "Was the medical services available in this community 'good', 'poor', or are you uncertain about the matter?" The responses to the question are summarized in Table 11.

TABLE 11—*Opinion of informants regarding medical services in their communities*

Community	Number of families	Opinion regarding medical service		
		Good	Uncertain	Poor
		Percent	Percent	Percent
Concord	104*	91	2	1
Stephenson	118	86	4	10
Mesick	211	22	27	51

*Six families in this community did not give an opinion.

The basis of these opinions varied. In general, the informants were inclined not to be critical of the kind of service they received, since if they did not feel satisfied with one doctor, they would go to another or would neglect seeing any doctor. The most frequent reason for judging medical service to be poor was the lack of its availability. This is well illustrated in the responses of informants in Mesick. Over half of the people there thought the medical service was poor because the community had no doctor except the one who had retired from active practice on account of age. A few informants also judged the medical service as being poor because they thought the doctors were too busy and consequently they had to wait an unduly long time at a doctor's office before they could see him.

Method of Paying for Medical Services: When the survey was made, the informants were asked whether the family had insurance for paying doctor bills or whether they followed the customary plan of paying for medical service after it was received. The replies showed that a majority in each community paid for medical service after it was received. In Concord, 20 families (19 percent of the total) had insurance for paying a part or all the medical bills for one or more members of the family. In Stephenson, 18 families (15 per-

cent of the total) had a similar arrangement for paying medical bills. In Mesick, 46 families (21 percent of the total) had made such plans. In almost every instance the family had the insurance because the employer of the breadwinner (usually the husband) had made it possible for the family to get insurance through a group payment plan.

DENTAL NEEDS AND DENTAL CARE

Among the questions pertaining to symptoms, four related to dental problems. Obviously they were not a complete list of symptoms that might occur in connection with dental care. Rather they were the more common symptoms which could be determined by the person himself. The four symptoms were toothache; inability to chew food because of "sore" or missing teeth; sore mouth due to bridges or plates; and repeated or frequently bleeding of gums. The extent of these symptoms among the families interviewed is shown in Table 12.

The fact that these symptoms occurred in about the same proportion in each of the three communities indicates that the need for more dental care is a general one. As explained earlier, there was a dentist in Concord and one in Stephenson. Mesick had no dentist. A certain proportion of the families in each community went outside the trade center to receive dental service. Obviously this was necessary for all Mesick families, but in Concord and Stephenson a certain number of families would go to a particular dentist in another community if they liked him. Only 13 families in Concord stated that they were unable to see a dentist when they wanted to. In the Stephenson community also, 13 families made the same complaint. In Mesick, 33 families were unable to get a dental appointment when they wanted one. It was necessary, they explained, to wait from 2 to 6 months for an appointment.

TABLE 12—*Number and percent of individuals having designated dental needs*

Symptom	Concord community (339 persons)	Stephenson area (438 persons)	Mesick community (736 persons)
	Percent	Percent	Percent
Toothache	7	7	7
Unable to chew food: sore teeth or missing teeth	5	4	8
Sore mouth due to bridges or plates	1	3	2
Repeated or frequent bleeding gums	2	*	3

*Less than 1 percent.

HOSPITAL SERVICES

None of the communities had a hospital. Consequently it was necessary for families needing this service to go to other communities. Concord families usually went either to a hospital in Jackson or Albion, cities which are not more than 20 or 25 miles from any home in the community. In Stephenson most of the families needing hospitalization used the Menominee hospital, which is about 25 miles from the town of Stephenson. In Mesick the families had to go to Cadillac, which is about 20 miles from Mesick, or to some other community which would be even farther away.

In Concord, a total of 30 families had one or more members who had been admitted to a hospital within a year preceding the survey. In Stephenson, 32 families had a need for hospital service.[5] Only one family in the Concord community and three in Stephenson stated that it was not possible to get into the hospital when they wanted to. The reason given for not being admitted was the fact that when the person wanted to go to the hospital there was no room except for emergency cases.

The practice of having insurance for a part or all of the hospital bills which a family might incur was much more frequent than insurance for paying doctor bills. The figures pertaining to this matter are presented in Table 13. In most instances the insurance was taken out in connection with the employment of the husband. A majority of the families felt that insurance or prepayment plans for paying hospital bills were a good idea.

TABLE 13—*Percentage of families in each community having hospital insurance for one or more family members*

Community	Number of families	Percent having insurance for hospital care for one or more family members
All communities	433	32
Concord	104	47
Stephenson	118	26
Mesick	211	27

[5]The number of families using a hospital was not ascertained in the Mesick community.

TABLE 14—*Percentage of persons over 3 months and under 16 years of age vaccinated for smallpox, diphtheria and whooping cough in areas surveyed*

Area	Number of persons	Percent vaccinated for:		
		Smallpox	Diphtheria	Whooping cough
Concord community	103	78	82	56
Stephenson area	137	81	89	57
Mesick community	256	68	59	31*

*Twenty-seven percent were not vaccinated but had had the disease.

PUBLIC HEALTH SERVICES

Two types of activities which come within the scope of public health programs were included in the questions asked of the families interviewed. One pertained to vaccinations for smallpox, diphtheria and whooping cough. The other related to examination by a county public health officer or nurse.

The essential data about vaccinations are presented in Table 14. The figures show that considerably more work needs to be done in this aspect of public health work if all children within the age limits designated in the table are to be vaccinated.

The results pertaining to the second question regarding public health services showed that 17 percent of the families in the Concord community had children who were examined by a county public health officer or nurse during the year preceding the survey. In Stephenson, the percentage was 18. In the Mesick community, 22 percent of the families reported such a contact with the public health service.

CONCLUSIONS

This survey of health and health facilities in three Michigan town-country communities shows that there were unmet needs for medical care in each one. The percentage of individuals having unmet medical needs was higher in the open country than in the towns. There seemed to be a relationship between the amount of unmet need for medical care and the lack of medical service in the community—the community not having a physician (except one who had retired) consistently had a higher percentage of unmet needs than did the other communities which had resident physicians.

The need for medical attention as determined by the number of positive symptoms reported for individuals increased with the age of the population. Also, the percentage of the population having positive symptoms increased as the gross income of the family became smaller.

The use of medical services varied. In two communities, about two-fifths of the individuals included in the sample had visited a doctor at least once during a period of 6 months preceding the time of the interview. Generally speaking, informants were satisfied with the service of physicians but many were dissatisfied with its availability. They felt that many times the doctors were too busy and consequently they had to wait an unduly long time in their offices.

Approximately one family out of each three had at least one person who had been hospitalized during the year preceding the survey. About one-third of the families had hospital insurance for one or more members of the family. A majority of the families thought that insurance or prepayment plans for hospitalization were a good idea.

The study shows a definite need for more public health work in the communities.

HOW MICHIGAN FARMERS USE POULTRY MARKETING INFORMATION

By CLARA HENNING LOWE *and* REX KING[1]
SECTIONS OF SOCIOLOGY AND ANTHROPOLOGY AND ECONOMICS

MICHIGAN poultry farmers must have available, be acquainted with, and make use of accurate and adequate information about marketing conditions in order to get the best price for the products they sell. Only when farmers are satisfied that they are receiving a fair price for their poultry products can the consumer be assured of an adequate flow of the poultry commodities needed.

PURPOSE AND METHODS

In order to determine the farmer's use of and reaction to market news information, questionnaires were constructed around four questions which were regarded as important in a study of effective dissemination of market information. These questions were:

1) What knowledge do farmers have about the available sources of market information?

2) What sources of information about market conditions do they customarily use?

3) How adequate and useful do they consider the available market information to be?

4) What suggestions do they have for improving the reporting of market conditions?

Since a farmer's use of poultry market news and information may be influenced by the size of his poultry flock, his marketing methods and his market outlets, questions designed to determine these and

[1]This article deals with one phase of a cooperative research project in which the Section of Sociology and Anthropology, represented by Edgar A. Schuler, Duane L. Gibson, and Clara H. Lowe, and the Section of Economics, represented by Henry E. Larzelere and Rex King, are participating, and to which the Section of Poultry Husbandry, represented by C. G. Card, Charles C. Sheppard, and others, has given very great help. This preliminary report was written by the two graduate research assistants, Mrs. Lowe and Mr. King, but the study at every point involved joint effort and constant collaboration.

ARTICLE 31-18

other related factors were included in this survey. The relationship of these factors to use of market news will be presented in the final report.

To develop a suitable sample of informants for the study, a mailing list of representative Michigan farmers was obtained from the U. S. Bureau of Agricultural Economics.[2] It was expected that a wider range of types of poultry production would be obtained if questionnaires were mailed to all farmers in the sample rather than only to those who were primarily poultry producers.

Every one of the 349 farmers on the B. A. E. mailing list was reached either by mail or personal interview. Of these, 121 farmers had sold eggs and/or chickens the previous year and would logically be expected to be interested in market information.

THE POULTRY ENTERPRISE ON THE FARMS STUDIED

It was found that of the 121 farms reporting chickens, 51 percent had fewer than 100 birds per flock, and an additional 24 percent of the flocks contained more than 100 but fewer than 200 birds. Twenty percent of the farms had over 200 birds per flock, and the rest either had no chickens at that time or did not answer the question. These figures, however, must be considered in relation to the season; most of the questionnaires were completed during March, when chicken flocks tend to be at their smallest. Forty-four percent of these returns reported that the wife handled the marketing of the eggs and poultry, and in another 16 percent of the cases she helped her husband with the marketing. In about 25 percent of the cases the husband did the marketing. Other members of the family and hired help accounted for another 10 percent of the farms.[3]

The most popular breed reported was the single-comb White Leghorn. Thirty-three percent of the informants listed them as the major breed. White Plymouth Rocks were reported on 23 percent of the farms, and Barred Plymouth Rocks on about a tenth of the farms. New Hampshire Reds were fourth, being listed for about 6 percent of the farms. Crosses and hybrids were the leading breeds on another 6 percent of the farms. Other breeds or combinations of breeds were listed for about 9 percent of the farms reported.

[2]This was a list of names and addresses of farmers in 22 counties chosen by the Bureau of Agricultural Economics as representative of the agricultural areas of Michigan for the 1947 Survey of Agriculture.

[3]Throughout this article there will be several places where the numbers given will not total 100 percent. The remainder are those who either did not answer, replied "don't know" or "none," etc.

Three-fourths of the 121 farmers said they obtained the major part of their poultry income during the past year from egg sales. Sales of chickens accounted for the major part of the poultry income on 18 percent of the farms. Other types of poultry, such as turkeys, geese, ducks, etc., were reported on only 18 farms, and in no case did these other types of poultry bring in any important amount of poultry income.

MARKETING PRACTICES

Among the 117 farmers who sold eggs during the past year, 35 percent graded their eggs for size at the farm and 28 percent checked their grading with an egg scale. Only 6 percent of these farmers candled their eggs for quality.

Twenty-seven percent of the 121 farmers sold most of their eggs to wholesale buyers. Another 27 percent sold directly to consumers, and 26 percent sold to retailers, such as local grocery stores. Hatcheries, hucksters, hospitals, and restaurants accounted for the rest of the sales outlets. This same question was asked of all the farmers as to their chicken sales with largely similar results. Thirty-three percent of the farmers sold to wholesalers (some of whom very likely were trucker-buyers), 23 percent sold directly to consumers, and only 8 percent sold to retailers. Other markets got a larger part of the total chicken sales than of egg sales.

Sixty-seven of the farmers replying had sold their eggs to the same buyer for 2 years or longer; an additional 19 farmers had sold to the same buyer for over a year but less than 2 years. The other 23 farmers who answered had sold to their current market for less than a year. Less than 28 percent of the farmers had their eggs picked up at the farm. But of the 33 farmers who either graded or candled their eggs, 18 said their buyers paid on the basis of the farm grading. Seventy-seven percent of the farmers who did not candle or grade their own eggs said their buyers paid them on a nest-run basis. About 10 percent of these farmers said their buyers sorted their eggs and paid for them on that basis.

Because the data for this survey were largely collected during March, it was expected there would not be many recent sales of chickens. Less than a fifth of the farmers showed that they had sold any chickens within the previous month. Fewer than 1 in 10 of the 121 farmers had sold more than 25 chickens within that period.

Of the 106 farmers who reported selling poultry at some time in the past year, 76 percent said they sold them as "live" poultry. Seven sold them as "drawn", and about four each sold them as "feather dressed" or as "feather dressed and drawn." Seventy-nine were paid for their chickens on a live-weight basis, and six each were paid on a feather-dressed or a drawn-weight basis. The others reported combinations of the above.

KNOWLEDGE ABOUT AND USE OF MARKET INFORMATION

It was assumed that data on farmers' attitudes toward selling prices would be helpful in a study of their use of market information, so this question was asked: "Do you generally set your own price, or do you take what you get?" Seven out of every 10 of these egg producers reported that they "had to take what they could get" while only 2 said that they set their own selling price. When our informants were asked the same question about their poultry sales, 6 out of every 10 of these farmers said that they had to take what they could get, and 3 reported setting their own price. Whether the majority of poultry and egg producers are actually in a situation where there is no competitive bidding for their product cannot be determined at this time. But it is significant that they *feel* that they are at this type of disadvantage when marketing their poultry products.

Better than 6 out of every 10 of the 121 poultrymen compared their selling price with some other price. Of these, about 4 out of the 10 used market quotations, 2 used local stores for comparisons, and the rest compared with other buyers, neighbors, or with several of the above-mentioned sources.

Of the poultrymen who compared their selling prices, 3 out of 10 used the radio as their source of information. Two used both newspaper and radio, and another 2 used only the daily paper. The remaining 3 in every 10 of these farmers either did not supply any information, or used combinations of sources, such as radio and neighbors, egg buyers and newspapers, farm papers, and radio, and so forth.

Of the poultrymen who compared their prices with other prices, 13 percent did not even know whether the quotations they consulted were wholesale or retail. About 50 percent of the farmers said that the quotations they consulted were wholesale, 21 percent reported

that the quotations they used were both wholesale and retail and 8 percent said that they used retail quotations only.

About half of the farmers who used market quotations as a basis for price comparison looked for a particular quotation. Of these, about two-thirds of the poultrymen looked for quotations which gave prices on eggs according to color. Particular size and grade quotations were also consulted by some of the poultrymen.

When asked to name sources of marketing information other than the source they now used, no additional sources were named by about half of the 121 farmers. Of those who did supply information, radio was the most often suggested with the daily newspaper next in line. The telephone, other buyers, local stores, and neighbors were also suggested.

Convenience was rated highest by the poultrymen when they were asked to state why they preferred to use their present source of market information. Other reasons for using their present source of market information were reliability and accuracy, speed of reporting current prices, and local quotations, in the order given.

The poultrymen who rarely or never used market quotations were asked to state why they did not use the information available. Three out of every 10 of these farmers did not answer the question at all, another 3 said they sold too few eggs to merit using the information, and one each answered, "no time," "have to take what we get," and "want retail prices, not wholesale." One in 10 of these had various reasons: "local buyers pay the same," "convenience of present source of price comparison," or "have trustworthy dealer."

SUGGESTIONS FOR IMPROVING MARKET REPORTING

When asked to make suggestions for improvement of the present marketing information, 32 percent of these poultrymen could not make suggestions as they did not consult radio or printed market information. Twenty-one percent used the question as an occasion to state some grievance they felt toward the farmers' place in the marketing setup as a whole and not in relation to the market quotations as they were available to them. Twenty-three percent did not answer the question at all. Twelve percent replied "none," "all right as is," "hadn't considered it" or "little use in changing." Four percent answered that they had "too few chickens." Only the 8 percent of the poultrymen remaining had any suggestions to offer. These in-

cluded the following: supply more local and district quotations; both wholesale and retail prices should be quoted; give retail prices; the grades should be broken into more categories for classification and pricing; and finally, weekly bulletins were desired.

CONCLUSION

In conclusion, it should be pointed out that this is a preliminary analysis. Further information regarding the use of poultry market information will be available when replies from the 1948 Survey of Agriculture in Michigan and from comparable questionnaires sent to turkey producers and to poultry dealers are analyzed. It will then be possible to amplify the present analysis, and test the reliability of the findings here reported.

JOURNAL ARTICLE ABSTRACTS

A Method for the Estimation of the Advancement of Vegetation by the Use of Daily Maximum Temperatures

PARTRIDGE, N. L.

Proc. Amer. Soc. Hort. Sci. 49: 7-14. 1947. [Journal Article 714 (n. s.) from the Michigan Agricultural Experiment Station]

Data comprising date of first blooms for peaches and daily maximum temperatures covering 24 seasons were used. Accumulations above various maximum temperatures ranging from 28° to 50° F. for periods beginning January 1, February 1, March 1 and April 1, respectively, and extending to the date of the first bloom of the peach, were calculated. The use of the coefficient of variability was an unsatisfactory measure of the approximation of the various indices to vegetation as indicated by peach bloom. A suitable means for evaluating the indices was determined and it was concluded that the accumulation could be commenced January 1, February 1 or March 1 without changing significantly the value of the resulting index. There was also a wide range of maximum temperatures of approximately equal value for bases. The use of an index calculated from a maximum temperature base of 40° F. commencing January 1 was suggested for Michigan conditions. Tables calculated on this basis for 26 seasons are given to illustrate the variation between seasons, the assumption being that the progress of vegetation will be rather closely correlated with these indices.

Effect of Soil and Seed Treatment with 2,4-Dichlorophenoxyacetic Acid on Germination of Seeds and Development of Seedlings

HAMNER, C. L., MOULTON, J. E., AND TUKEY, H. B.

Bot. Gaz. 107 (3): 352-361. 1946. [Journal Article 795 (n. s.) from the Michigan Agricultural Experiment Station]

The normal germination of many seeds can be affected by soaking in low concentrations of 2,4-D. Pronounced morphological changes occur when certain seeds are treated in solutions as low as 1 p.p.m. It is thus evident that certain germinating seeds and very young seedlings are much more responsive to the chemical than are more advanced seedlings and established plants. Not only can seeds of broad-leaved plants be killed with 2,4-D but seeds of many of the grasses can be destroyed when 2,4-D is applied in the soil. The toxic effect of 2,4-D in the soil persisted for about 3 weeks after which time it rapidly disappeared so that by the end of 4 weeks it was almost completely gone.

Hemoglobin Concentrations in the Blood of Normal and Estrogen-treated Turkeys

WOLTERINK, L. F., REINEKE, E. P., AND DAVIDSON, J. A.

Am. Jour. Vet. Res. 8: 431-436. 1947. [Journal Article 801 (n. s.) from the Michigan Agricultural Experiment Station]

The influence on the blood hemoglobin of diethylstilbestrol when given by injection and the dimethyl ether of diethylstilbestrol when given orally was determined in Standardbred Bronze, Broadbrest Bronze and Standardbred X Broadbrest turkeys.

As determined by the Sheard-Sanford Method, the normal hemoglobin concentration in the three varieties of Bronze turkeys between the ages of 21-28 weeks was 13 to 15 gm. per 100 cc.

Diethylstilbestrol suspensions injected into the neck wattle produced a marked anemia with large dosages and a mild anemia with smaller dosages.

The dimethyl ether of diethylstilbestrol given as 0.01 percent of the feed for 29 to 31 days reduced the hemoglobin concentration in the blood of turkeys to about three-fourths of the control values.

The Role of Vitamin A in Bovine Nutrition

LANGHAM, R. F.

M.S.C. Veterinarian. 6: 14-16, 31-34. 1946. [Journal Article 819 (n. s.) from the Michigan Agricultural Experiment Station]

This paper is a review of the literature on the role of vitamin A in the bovine.

The chief sources of provitamin A are good green grasses and hay, and yellow corn. Colostrum is one of the richest sources for calves.

The minimum requirement of carotene per day per kg. of body weight lies between 26 and 33 micrograms. The chief symptoms of vitamin A deficiency are night blindness, papillary edema, pityriasis, reproductive failure, dead and weak calves, retention of the fetal membranes, scours, pneumonia, increased cerebrospinal pressure, subcutaneous edema, and lameness. Thirty-five references were covered in the paper.

The Equilibrium Moisture Content of Alfalfa Hay When Exposed to Air at Various Relative Humidities

DEXTER, S. T., SHELDON, W. H., AND WALDRON, D. I.

Agr. Eng. 28 (7): 295-296. 1947. [Journal Article 825 (n. s.) from the Michigan Agricultural Experiment Station]

Samples of alfalfa hay, both dried and undried, were exposed to atmospheres of various relative humidities over sulfuric acid solution until an equilibrium of moisture content was attained. In general, molding occurred at relative humidities of 85 percent or higher within a period of 1 or 2 weeks. Samples high in protein appeared to absorb moisture more at high relative humidities than did samples lower in protein. Freshly harvested samples with cells still living maintained a far higher moisture content and molded more readily at high relative humidities than did samples dried before such exposure to high humidity.

Barn-dried alfalfa did not absorb moisture from air with a relative humidity of 80 percent, unless the moisture content of the hay was below 15 percent which is considered dry enough to keep in ordinary storage.

The Urinary Excretion of Riboflavin by College Women

BREWER, W., PORTER, T., INGALLS, R., AND OHLSON, M.

Jour. Nutr. 32: 583-596. 1946. [Journal Article 830 (n. s.) from the Michigan Agricultural Experiment Station]

The urinary excretion of riboflavin of 14 college women was studied under the following conditions: 1) self-selected diet; 2) usual diet supplemented daily with 3 mg. of riboflavin; 3) controlled diet at six riboflavin intakes; and 4) 24-hour excretion after a 3 mg. dose of riboflavin following each period of controlled intake. From three to nine subjects were studied at each of the following riboflavin intakes: 0.79, 1.04, 1.25, 1.62, 2.23, and 2.73 mg. daily.

Urinary excretion of riboflavin on self-chosen diets ranged from 144 to 850 mcg. per 24 hours. The average urinary riboflavin for the last three days of each period of controlled diet was, respectively, 0.07, 0.16, 0.13, 0.32, 1.18 and 1.31 mg. per 24 hours.

A study of the daily excretions and the excretion of the test dose after each dietary period indicated that 2.23 mg. were in excess of the needs of the subjects. Four subjects showed a sharp increase in urinary excretion of the test dose after an intake of 1.26 mg. and did not use additional vitamin to apparent advantage. For two subjects the data were incomplete but it appeared that the increase in excretion of test dose occurred between intakes of 1.26 and 1.62 mg. For four subjects the upper limit of intake which maintained tissue stores was not determined but an intake of 1.62 mg. seemed to approach this point.

All of the subjects were in good physical health throughout the experiment.

Discoloration of Potatoes after Cooking as Related to Their Composition

BANDEMER, SELMA L., SCHAIBLE, P. J., AND WHEELER, E. J.

Amer. Potato Jour. 24 (1): 1-6. 1947. [Journal Article 840 (n. s.) from the Michigan Agricultural Experiment Station]

Moisture, ash, manganese, iron and pH were determined on Sebago, Chippewa, Green Mountain, and Russet Rural varieties of Michigan-grown potatoes and correlated with the degree of discoloration obtained after steaming.

The correlations between discoloration and moisture, between moisture and pH and between discoloration, moisture and pH were all highly significant within lots. That between discoloration and pH was significant within some lots. The discoloration increased with increased moisture and decreased pH.

The study indicated that moisture is a dominant factor in discoloration of cooked potatoes but its influence is upon some more directly involved component.

A Comparison of the Babcock, Gerber, Minnesota, Pennsylvania and Mojonnier Methods for Determining the Percentage of Fat in Homogenized Milk

TROUT, G. M. AND LUCAS, P. S.

Jour. Dairy Sci. 30 (3): 145-159. 1947. [Journal Article 841 (n. s.) from the Michigan Agricultural Experiment Station]

Comparisons were made on the relative efficiency of the Babcock, Gerber, Minnesota, Pennsylvania, and Mojonnier methods for determining the percentage of fat in homogenized milk. The data indicated that:

Homogenization does not affect the Mojonnier fat test of milk.

The modified Babcock method (17.5 ml. of 1.835 sp. gr. sulfuric acid added in three portions, 8, 5, and 4.5 ml., respectively, and shaken for at least 2 minutes before centrifuging) may be used with much assurance of accuracy in testing homogenized milk. Twenty-four tests in duplicate averaged within −0.012 percent of those of nonhomogenized milk made by the same method and within +0.043 percent of the Mojonnier average.

Homogenization does not affect the Gerber test. The average Gerber tests, both of nonhomogenized and homogenized milk, were found to be 0.09 percent higher than those secured by the Mojonnier method. Aside from the necessity of introducing another test and the fact that the readings were approximately 0.1 percent higher than the Mojonnier, the Gerber test was by all odds the most satisfactory test studied for making fat tests of homogenized milk.

While the Minnesota method yielded average tests of homogenized milk within +0.027 percent of those of nonhomogenized milk, the tests varied from those of the Mojonnier on the average by −0.433 percent. It would seem, therefore, that the test could not be recommended for testing homogenized milk.

The Pennsylvania method, yielding tests on homogenized milk in these studies markedly lower than the Mojonnier method, cannot be recommended for testing homogenized milk.

The Effect of Soil Aeration, Moisture, and Compaction on Nitrification and Oxidation and the Growth of Sugar Beets Following Corn and Legumes in Pot Cultures

SMITH, F. W. AND COOK, R. L.

Soil Sci. Soc. Am. Proc. 11: 402-406. 1946. [Journal Article 843 (n. s.) from the Michigan Agricultural Experiment Station]

Sugar beets were grown in Brookston clay loam pot cultures following corn, alfalfa, and sweet clover. One-half of the cultures were excessively compacted. One-half of the pots in each compaction treatment were maintained at a moisture content equal to the moisture equivalent which was 25 percent. The other one-half were held at 28.2 percent moisture. Each compaction and moisture content treatment was still further divided on the basis of normal and forced aeration.

The degree of oxidation in the soil was determined by measuring ferrous and ferric iron and bacterial activity was measured by determining nitrate nitrogen in the soil.

Certain conclusions were evident from the results obtained. Excessive compaction greatly decreased sugar beet yields and the presence of excessive soil moisture magnified the detrimental effects of compaction. The compaction and excessive soil moisture caused disturbances in the oxidation and nitrification processes within the soil. Aeration was an important factor in the production of sugar beets. There was strong evidence that effective air capacity of the soil was an important factor. Inadequate aeration was more injurious to sugar beets following legumes than to beets following corn. Top growth cannot be taken as a measure of sugar beet yields.

A Greenhouse Study of Deficiency Symptoms in Sugar Beets with Details for the Preparation of Balanced Nutrient Solutions

WEIDEMANN, A. G. AND COOK, R. L.

Proc. Soil Sci. Soc. Am. 11: 361-368. 1946. [*Journal Article 844 (n. s.) from the Michigan Agricultural Experiment Station*]

A knowledge of symptoms of nutrient deficiency in plants is becoming a useful tool in the hands of agricultural workers who give advice to farmers regarding use of fertilizers. To become acquainted with the specific symptoms, which vary with the nutrient and the crop, good use has been made of nutrient solutions in sand cultures.

Sugar beets, an important crop in Michigan, were grown in nutrient solutions from which, in different treatments, various elements were singly omitted. Thus, characteristic symptoms were identified and are described.

The elements studied were nitrogen, phosphorus, potassium, calcium, magnesium, manganese, zinc, copper, boron and iron. The relatively insoluble salts such as $FePO_4 .4 H_2O$ and $CaHPO_4 .2 H_2O$ were mixed with the dry sand at the beginning of the experiment while the soluble salts were added in solution as the experiment progressed. Three trials were conducted. In the second and third trials the applications of certain salts were increased and other changes were made. In the first trial no attempt was made to maintain a certain rate of application of the different elements when making adjustments for omitting one element, but in the second and third trials the solutions were so balanced that each of the tested elements present, except iron, was maintained at the same concentration for all treatments. Methods, figures, and calculations are presented for making these balances.

During the progress of the experiments observations were made, and symptoms and other conditions recorded by figures and photographs. Finally, the plants were harvested, weighed and photographed.

During the growth of the plants it was found necessary to supply small quantities of nitrogen, phosphorus, potassium, calcium, magnesium and boron to keep the plants alive. In the later trials, where growth had been increased by heavier applications of the more essential elements, minor element deficiencies became more prevalent. The absence of iron caused serious deficiency symptoms and a reduction in yield. The absence of manganese resulted in deficiency symptoms but did not affect yields. No indication of copper and zinc deficiency occurred and yields were not retarded where these elements were omitted from the nutrient solutions.

Some Techniques Which Help to Make Greenhouse Investigations Comparable with Field Plot Experiments

COOK, R. L. AND MILLAR, C. E.

Soil Sci. Soc. Am. Proc. 11: 298-304. 1946. [*Journal Article 846 (n. s.) from the Michigan Agricultural Experiment Station*]

The results obtained from greenhouse pot culture experiments have been found to be greatly influenced by the techniques employed and by the environmental conditions under which the experiments were performed. By making use

of certain methods of procedure, good correlation has resulted between greenhouse and field results. This has been true in a rotation experiment where the greenhouse pots were filled with soil taken from the corresponding plots in the field. In fertilizer studies with sugar beets in the field, five farms were rated in the order of their response to fertilizers. In an experiment in the greenhouse, using soil from these farms, they fell in the same order, except that the last pair, those showing least response, was reversed.

Certain techniques help to make greenhouse investigations comparable with field plot experiments. In general, containers should be large. For many experiments 1- or 2-gallon jars are too small.

Nutrient levels, on an acre, must be much higher in the greenhouse than in the field. If growth is good, yields may be several times as high per unit surface area as in the field.

Generally, it is better to place fertilizer near the top of the soil column, close to the seed, than to place it deeper in the soil.

Irrigation at the top of the soil in the conventional manner has been shown to be better than the introduction of water at the bottom of the pot through glass tubes.

During a 4-year period, soil structure has been maintained by removing the soil from the pots when dry between crops and passing it through a 4-mesh sieve, then returning it to the pots in an air-dry condition.

Summer time temperature control has been made possible by use of an outdoor screened-in area. This has made it possible to grow healthy crops during seasons which are normal with respect to both temperature and length of day.

The Fog Machine for Applying Pre-harvest Drop Materials to Apple Trees

HAMNER, C. L. AND RASMUSSEN, E. J.

Am. Soc. Hort. Sci. Proc. 49: 78-80. 1947. [Journal Article 853 (n. s.) from the Michigan Agricultural Experiment Station]

The fog machine has been used successfully for the application of naphthalene acetic acid as a pre-harvest spray to prevent drop of Oldenburg apples. The naphthalene acetic acid in "fogging" treatment was slightly more effective in delaying the pre-harvest drop of Oldenburg up to 12 days after application than was the standard method of water spray application.

The Effect of Thiouracil on Efficiency of Gains and Carcass Quality in Swine

MCMILLEN, W. N., REINEKE, E. P., BRATZLER, L. J., AND FRANCIS, M. J.

Jour. An. Sci. 6 (3): 305-309. 1947. [Journal Article 854 (n. s.) from the Michigan Agricultural Experiment Station]

The effect of thiouracil fed as 0.1 percent of the ration on economy of gains and carcass quality was studied with Chester White, Yorkshire and crossbred market pigs.

Compared with the controls, five Chester White barrows averaging 162 pounds and fed *ad libitum* for 41 days on a ration containing thiouracil made 0.16 pound less daily gain, but required 13.8 percent less feed per unit of gain. Five Yorkshire pigs given thiouracil for the same period averaged 0.09 pound less daily

gain and required 18.8 percent less feed per unit of gain. Nine crossbred pigs fed thiouracil at a different season made 0.35 pound less daily gain and required 8.4 percent less feed per unit of gain than their controls.

All of the pigs in the experimental groups became lazy toward the end of the second week and became increasingly sluggish as the trial progressed. The greater increase in the economy of gain in the Yorkshires as compared with the Chester Whites is believed to be due to a higher natural thyroid secretion rate in the former and consequently a greater reduction in rate of metabolism under the influence of thiouracil. There were no significant differences in the carcasses attributable to the thiouracil treatment.

Results of Spraying and Dusting Potatoes in Michigan in 1946

MUNCIE, J. H. AND MOROFSKY, W. F.

Am. Potato Jour. 24 (6): 183-187. 1947. [*Journal Article 856 (n. s.) from the Michigan Agricultural Experiment Station*]

In the experiments at the Lake City Experiment Station, potatoes sprayed with Dithane-zinc sulfate-lime DDT and F48-Bordow-Dethyl gave yields significantly better than those of any other materials employed. It seems possible that lack of injury to the plants from these materials or this factor and the added effect of DDT may be responsible for the increased yields. Bordeaux mixture 8-12-100, Zerlate and Yellow Cuprocide Tribasic-DDT ground together and DDT alone resulted in yields higher than those of the other materials employed, although these differences in yield were not statistically significant in every case.

The results of the dusting experiments, using fixed coppers in comparison with monohydrated copper sulfate-lime showed no significant differences in yield between these materials plus DDT or DDT alone.

Considerable variation in yield was found between plots sprayed with the same materials in different counties in the upper peninsula. Using the plots of identical materials in each of three counties as added replicates of materials, there was no significant difference in yield between the various sprays.

Late blight was absent in the Lake City Experiment Station tests and early blight was present in only slight amounts. In the upper peninsula plots late blight was present in Menominee, Schoolcraft, Marquette and Houghton counties, but its development was stopped by early killing frosts before any appreciable damage resulted.

Trials of New Sugar Beet Varieties for Michigan

KOHLS, H. L.

Proc. Am. Soc. Sugar Beet Technologists. 112-114. 1947. [*Journal Article 862 (n. s.) from the Michigan Agricultural Experiment Station*]

Ten sugar beet hybrids were tested in comparison with a standard variety in two localities, Saginaw and Lenawee counties, in 1947. Previous trials were in Ingham County. These preliminary tests indicated that five hybrids were significantly higher in yields of sugar per acre than the standard variety U.S. 215 X 216 and were resistant to leaf spot.

The Influence of Domestic Ryegrass and Redtop upon the Growth of Kentucky Bluegrass and Chewing's Fescue in Lawn and Turf Mixtures

HARRISON, C. M. AND ERDMAN, M. H.

Jour. Am. Soc. Agron. 39 (8): 682-689. 1947. [Journal Article 863 (n. s.) from the Michigan Agricultural Experiment Station]

The four grasses were sown at various rates in pure culture and in mixture to test the competitive effects of the "nurse" grasses — redtop and ryegrass — on the establishment of bluegrass and fescue.

In mixture, both domestic ryegrass and redtop inhibited the growth of Kentucky bluegrass and Chewing's fescue. The ryegrass and redtop dominated the mixtures in which they made up 20 percent or more by weight of the mixture. This dominance did not diminish with time.

Where quick cover is not essential, sowing of an adapted, desired species alone would result in a more satisfactory turf than a mixture which includes the coarser, more aggressive nurse grasses.

Effect of Various Mulching Materials on Orchard Soils

TURK, L. M. AND PARTRIDGE, N. L.

Soil Science. 64 (2): 111-125. 1947. [Journal Article 866 (n. s.) from the Michigan Agricultural Experiment Station]

In the fall of 1939, an experiment, involving the use of lysimeters, was started for the purpose of studying the effect of different kinds of mulching materials on the accumulation of soil nitrates and the conservation of soil moisture. The surface soil (7 inches) of three soil types (Coloma sand, Hillsdale sandy loam, and Miami silt loam) was used, and mulches of alfalfa hay, straw, and straw plus ammonium sulphate were applied to each of the three soils; other lysimeters received no mulch. Additional mulches of peat, shredded corn stover, shredded corn stover plus ammonium sulphate, sawdust, shavings, and gravel were used on the Hillsdale sandy loam. Each treatment was made in triplicate and determinations were made of the quantity of water which percolated through the soils, the amount of nitrates produced, and the changes in exchangeable cations in the soils. With the exception of peat all mulches were effective in decreasing evaporation losses of water. The peat mulch had such a high absorptive capacity for water that with light rains or long intervals between rains very little water reached the soil. The quantity of nitrates produced in the unmulched soils was greater than in the mulched soils except where alfalfa was used and in those soils which had received straw mulch plus ammonium sulphate. The decrease in nitrate production under straw mulch and similar types of mulching materials is believed due to poorer aeration brought about primarily by a higher soil moisture content and to a somewhat lower temperature. In general, the least depressive effect on nitrate production occurred in the better aerated soil. Mulches such as alfalfa, straw, and corn stover contribute materially to the plant nutrient content of the soil.

The Effect of Pre-packaging and Refrigeration of Strawberries on the Water Loss, Spoilage, Vitamin C Content and Sugar-Acid Ratio of the Fruit

MOULTON, J. E.

Am. Soc. Hort. Sci. Proc. 50: 263-268. 1947. [Journal Article 870 (n. s.) from the Michigan Agricultural Experiment Station]

Wooden and paper quart boxes containing the Robinson variety of strawberry were wrapped in one of three different types of films (Cellophane, Pliofilm, and Cellulose acetate). One lot of fruit was stored under refrigeration for 3 days while a second lot was held at 80° F. for 2 days.

The appearance of the strawberries was improved by the use of a cap or overwrap of any one of the three films employed in these tests. Loss of moisture was decreased by the use of a relatively impermeable film like pliofilm, but temperature changes caused condensation of moisture within packages wrapped in this way. This moisture in turn favored softening and darkening of the fruit. There was little fogging of the film when cellulose acetate was used. The quality of the fruit as indicated by spoilage, mold counts, the vitamin C level, and sugar-acid analyses, was not appreciably affected by the type of film used, the method of wrapping the package or the material of which the box was made.

At 35° F., moisture loss, spoilage and molding of the berries were significantly reduced as compared with fruit stored at 80° F.

Better Quality Hay

DEXTER, S. T., SHELDON, W. H., AND HUFFMAN, C. F.

Agr. Eng. 28 (7): 291-293. 1947. [Journal Article 871 (n. s.) from the Michigan Agricultural Experiment Station]

A program for better hay demands better hay species, better fertilization and cutting practices, even on poorer species, and better curing.

The quality of the cured hay can be no higher than the quality of the material that passes over the mower cutter bar.

Immature hays are difficult to cure, but may have high feeding values.

From feeding trials with mow-cured and other hay, the conclusion is reached that hay quality is best preserved by rapid drying in the mow or in the field, and that protracted drying is detrimental, even though no mustiness occurs.

Weed Control with 2,4-Dichlorophenoxyacetic Acid and Related Compounds and Their Reduced Effect under Varying Environmental Conditions

JORGENSEN, C. J. C. AND HAMNER, C. L.

Bot. Gaz. 109 (3): 324-333. 1948. [Journal Article 872 (n. s.) from the Michigan Agricultural Experiment Station]

The residual effect of 2,4-D in the soil was studied under varying environmental conditions. There was no appreciable difference in weed seed kill by the acid, the sodium salt, or the methyl ester of 2,4-D applied to Coloma sand. Higher temperatures resulted in disappearance of toxicity of sodium salt of 2,4-D from the soil more rapidly than did freezing or sub-freezing temperatures. Differ-

ences in pH value of Coloma sand did not appreciably affect the rate of loss of toxicity under the conditions of the experiment. In water-saturated flats sodium salt of 2,4-D disappeared in 3 weeks while in air-dried flats toxicity was still present after 8 weeks. Corn was more highly resistant to 2,4-D materials under all conditions than either peas or radishes.

The Moisture Content of Various Hays in Equilibrium with Atmospheres at Various Relative Humidities

DEXTER, S. T.

Jour. Am. Soc. Agron. 39 (8): 697-701. 1947. [Journal Article 874 (n. s.) from the Michigan Agricultural Experiment Station]

Values for the equilibrium moisture content of various mature and immature hays at various relative humidities are given. It is shown that immature hays are higher in moisture content at high relative humidities than are mature hays. Molding was visible on all samples of hay and straw within 10 days at a relative humidity of 85 percent. The amount of mold development at 85-percent relative humidity was greater in immature hays than in mature hays or straws. The development and occurrence of molds was determined by the relative humidity of the atmosphere rather than by the moisture content of the hay. Thus, an immature hay at 17- or 18-percent moisture might show no sign of mold (at 75-percent relative humidity) when a mature hay at 15- or 16-percent moisture and a relative humidity of 85 percent was plainly molded. To avoid relatively prompt molding in any hay, the relative humidity of the surrounding atmosphere must be kept below 85 percent.

Listerellosis in Sheep of Michigan

GRAY, M. L., THORP, F., NELSON, R. H., AND SHOLL, L. B.

M.S.C. Veterinarian. 7: 161-163. 1947. [Journal Article 879 (n. s.) from the Michigan Agricultural Experiment Station]

Four cases of Listerellosis in sheep have been confirmed by isolation and identification of *Listerella monocytogenes*. Three cases, two ewes and a lamb, occurred in the same flock and the fourth case in a nearby flock. The infection in the ewes was manifested by a central nervous system disorder while the lamb displayed a typical septicemia. The cultures when injected intracerebrally into rabbits produced death in from 20 hours to 4 days. In all instances listerellae were isolated from the brain and liver. When instilled into the eye of rabbits it produced a marked keratitis and conjunctivitis within 36 hours which persisted for 4 days.

Physical Action of Surface-active Cations upon Bacteria

KIVELA, E. W., MALLMANN, W. L., AND CHURCHILL, E. S.

Jour. Bact. 55 (4): 565-572. 1948. [Journal Article 880 (n. s.) from the Michigan Agricultural Experiment Station]

The bacteriostatic effect of surface-active cations on bacterial spores can be reversed by dilution and shaking in distilled water or physiological saline solution.

The reversal of the bacteriostatic effect of surface-active cations by the removal of the cations adsorbed on the bacterial spores by dilution was proved by demonstrating that negative mobilities of the spores were restored by washing the cells with distilled water.

The high osmotic pressure exerted on the bacterial cell by the adsorbed surface-active cation may explain, in part, the destruction of vegetative cells by the discharge of cell fluids into the suspending solution.

Segregation in Russeted Sports of the Grimes Apple

GARDNER, V. R., TOENJES, W., AND GIEFEL, M.

Jour. Agr. Res. 76 (11): 225-229. 1948. [Journal Article 883 (n. s.) from the Michigan Agricultural Experiment Station]

Individual trees propagated from buds of russeted limb sports of the Grimes apple showed marked differences in the degree of russeting of their fruits. Some trees bore fruits rather uniformly russeted, like the parent limb sport; others bore fruits that uniformly showed almost complete reversion to the normal smooth Grimes; still others showed an intermediate degree of reversion. One tree, grown from a single bud of the parent limb sport produced limbs each of which bore fruits comparatively uniform in degree of russeting, but differing from each other. Thus there was limb-to-limb segregation and reversion in some daughter trees and whole-tree segregation and reversion in others.

Variability and Segregation in the Golden Russet Apple

GARDNER, V. R., TOENJES, W., GIEFEL, M., AND KREMER, J. C.

Jour. Agr. Res. 76 (11): 231-240. 1948. [Journal Article 884 (n. s.) from the Michigan Agricultural Experiment Station]

Numbered labels were attached to 5,000 fruiting spurs on two old Golden Russet apple trees in the fall of 1933. Their fruits were classified as to amount of russeting and each year for 6 succeeding seasons fruits borne by the same spurs were similarly classified. There was a wide range in degree of russeting any single season on each tree, though certain seasons were characterized by considerably more russeting than others. It was found that certain large branches, year after year produced fruits with significantly more or significantly less russeted fruits than did other branches on the same trees. Furthermore, some of the daughter trees propagated from selected branches of the parent trees similarly produced fruit with relatively little or relatively much russeting; still other daughter trees showed a wide range in amount of russeting, thus resembling the parent trees. The data are interpreted as indicating that the Golden Russet apple is a chimera in respect to fruit russeting.

Segregation in a Radially Unsymmetrical Sport of the Canada Red Apple

GARDNER, V. R., TOENJES, W., AND GIEFEL, M.

Jour. Agr. Res. 76 (11): 241-255. 1948. [Journal Article 885 (n. s.) from the Michigan Agricultural Experiment Station]

A large-fruited, radially unsymmetrical bud sport of the Canada Red apple is described. It is classified as a sectorial chimera. Topgrafts and nursery-grown

trees propagated from the parent sport produced fruits that for the most part were radially unsymmetrical. There were, however, a number of segregates which appeared to be constant. These included large-fruited, normal sized and small-fruited regular or radially symmetrical strains. The large-fruited, radially symmetrical strains appear to be valuable for commercial propagation.

Rumen Digestion Studies. I. A Method of Investigating Chemical Changes in the Rumen

HALE, E. B., DUNCAN, C. W., AND HUFFMAN, C. F.

Jour. Nutrition. 34 (6): 733-746. 1947. [Journal Article 886 (n. s.) from the Michigan Agricultural Experiment Station]

A critical appraisal of the lignin ratio method was made to obtain information on the rate of digestibility of various components in roughage. A theoretical and experimental basis for the calculation of the rumen digestion coefficients is presented. By the use of the suggested formulae, measurements can be made either of maximum digestion or the rate of rumen digestion. Lignin values form the basis of both of these procedures but are applied in two distinct ways. These methods are not suitable for determining digestion coefficients of mixed rations since concentrates are not only low in lignin but they also pass from the rumen more rapidly than roughages. The principles forming the basis for the rumen digestion calculations received special attention.

Rumen Digestion Studies. II. Studies in the Chemistry of Rumen Digestion

HALE, E. B., DUNCAN, C. W., AND HUFFMAN, C. F.

Jour. Nutrition. 34 (6): 747-758. 1947. [Journal Article 887 (n. s.) from the Michigan Agricultural Experiment Station]

Studies of the chemical changes in the bovine rumen show that during the first 6 hours after feeding there was rapid digestion of proteins and carbohydrates. The predominant phenomenon during the second 6 hours was a rapid disintegration of cellulose. The digestion of proteins and carbohydrates paralleled the digestion of cellulose. Rumen digestion came to a standstill within 12 hours after feeding and prolonged digestion periods up to 24 hours did not increase rumen digestion coefficients. Average rumen digestion coefficients for 8 trials at 12-14 hours after feeding were: dry matter 48.4, protein 59.6, nitrogen-free extract 65.2, crude fiber 27.2, cellulose 43.4, other carbohydrates 83.0 and lignin 3.1 percent. After plant fragments pass from the rumen variable amounts of lignin may be digested, thereby exposing varying amounts of cellulose and protein to further digestion. The caecum plays only a supplementary role in the disintegration of roughage in the ruminant. An average of 11.6 percent of the cellulose and 9.5 percent of the protein was found to be digested in the caecum. The production of fatty acids in the rumen was demonstrated. Maximum increases, after the increase due to digestion was eliminated, were 54.9 percent on an alfalfa hay ration and 281.7 percent on a beet pulp ration. The rapid dissipation of fatty acids from the rumen together with the marked synthesis suggest that fatty acids make a highly significant contribution to the nutrition of the ruminant.

The Immunization of Guinea Pigs with Mucoid Phases of Brucella

HUDDLESON, I. F.

Am. Jour. Vet. Res. 8: 374-380. 1947. [*Journal Article 888 (n. s.) from the Michigan Agricultural Experiment Station*]

When live cell suspensions of certain mucoid growth phases of *Brucella suis* and *Brucella melitensis* were prepared in a suitable concentration and injected into normal guinea pigs, they were capable of engendering a high degree of active immunity against experimental infection with all three species of Brucella.

Cell suspension of *Br. suis*, M phase 2, after irradiation with ultra-violet light to a sufficient degree to render all but a few cells in a 1-mg. dose nonviable, were also capable of producing a high degree of immunity in guinea pigs against experimental infection with *Br. suis* and *Br. melitensis*.

The vaccine-treated guinea pigs that were found free from infection after exposure did not show specific agglutinins in the blood serum in dilutions of 1:25 or above.

The results of the experiments reported herein suggest the possibility of obtaining a high degree of immunity with this type of Brucella vaccine against brucellosis in animals and human beings.

Cannibalism and Feather Picking in Chicks as Influenced by Certain Changes in a Specific Ration

SCHAIBLE, P. J., DAVIDSON, J. A., AND BANDEMER, S. L.

Poultry Science. 26 (6): 651-656. 1947. [*Journal Article 890 (n. s.) from the Michigan Agricultural Experiment Station*]

The vicious habit of picking feathers, comb, wings, toes, tail, vents, and other parts of the body of the chicken is one of the serious problems of keeping poultry in confinement. Environmental factors as well as nutrition involving various management procedures have been cited as the causes of this habit.

A basal ration containing a high percentage of yellow corn and a low content of protein, phosphorus and fiber produced a high incidence of cannibalism and feather picking in chicks started in a chick starting battery. Various ingredients were added to the basal ration and the difference in cannibalism and feather picking noted. These ingredients included inorganic supplements including different calcium compounds and sodium compounds, several sources of fiber, and various protein supplements.

Certain of the protein supplements seemed to be more effective than others, with casein being the principal ingredient which at various levels reduced the amount of picking and cannibalism. At a 2-percent level, casein reduced cannibalism and improved feathering while 3.6 percent was required to reduce feather picking.

The time of year is not an important factor. The results of these experiments indicate that malnutrition may of itself result in feather picking and cannibalism in White Leghorn chicks.

The Amino Acid Composition of Bovine Semen

SARKAR, RAY B. C., LUECKE, R. W., AND DUNCAN, C. W.

Jour. Biol. Chem. 171 (2): 463-467. 1947. [*Journal Article 893 (n. s.) from the Michigan Agricultural Experiment Station*]

An amino acid analysis of a composite of 149 semen samples obtained from 40 different bulls is reported. These bulls were used routinely for artificial insemination and were of the Holstein, Guernsey, and Jersey breeds. The semen was centrifuged at 5,000 r.p.m. and the sperm separated from the seminal plasma. The sperm and seminal plasma were frozen and dried in this state by sublimation. The concentration of 11 amino acids in the sperm and seminal plasma is reported. With the exception of arginine, leucine, and tryptophan, the amino acid composition of sperm and seminal plasma is quite similar. The arginine content of sperm is very high but is relatively much lower in seminal plasma. The tryptophan concentration in seminal plasma is considerably higher than that found in sperm.

The Establishment and Comparative Wear Resistance of Various Grasses and Grass-Legume Mixtures to Vehicular Traffic

MORRISH, R. H. AND HARRISON, C. M.

Jour. Am. Soc. Agron. 40 (2): 168-179. 1948. [*Journal Article 894 (n. s.) from the Michigan Agricultural Experiment Station*]

In an attempt to measure the comparative wear resistance of grasses and grass-legume mixtures, traffic was applied to a series of plots which had been established in 1943 and 1944. Seedings were made in April, June, August and October of each year in order to determine the optimum time of planting.

Seedings made in April, August and October were superior to the June seedings and produced an average of about 18 percent more ground cover than did the latter. The October seedings performed as dormant seedings and produced cover the following spring. Seeding in excess of 40 pounds an acre did not seem to be justified as measured by the quantity and quality of the sod produced.

All plots were subjected to traffic with a passenger car weighing 3,300 pounds. A truck weighing 4,000 pounds was used on the April and June seedings of the 1943 series. Four hundred trips were made with the car and 210 with the truck on the April and June seedings of the 1943 series.

The major portion of the traffic was applied in October 1946 when the moisture content of the surface soil was approximately 7 percent. Rutting and deformation resulting from the loads applied was negligible.

Kentucky and Canada bluegrass and Chewing's, sheep and tall fescue produced the most wear-resistant turfs. Redtop was intermediate in its resistance to wear, and timothy, bromegrass, and orchard grass were the least resistant. Alfalfa and red clover wore off at the surface of the ground long before the grasses showed any serious effect from traffic. Domestic ryegrass had disappeared from the plots at the time of testing. The inclusion of domestic ryegrass in the mixtures appeared to be detrimental in the establishment of wear-resistant turfs.

The bluegrasses recovered from intensive wear more rapidly than did the fescues. Orchard grass, timothy, and bromegrass were the slowest to re-establish a satisfactory cover.

The Nutritive Value of Canned Food. I. Handling and Storage Procedures for Vegetables Prior to Canning

MARSHALL, R. E. AND ROBERTSON, W. F.

Food Technology. 2 (2): 133-143. 1948. [Journal Article 897 (n. s.) from the Michigan Agricultural Experiment Station]

The time interval between harvesting and canning of spinach, asparagus, peas, green beans, sweet corn, lima beans, and carrots was varied from approximately 2 hours to what is generally considered by industry as long-time holding for the several commodities, and methods of holding items other than carrots included: 1) holding in shade at prevailing out-door temperatures, 2) holding in vats continuously supplied with running tap water, 3) washing shelled peas and lima beans before storage to remove viner juice, 4) cold storage at 33° F., and 5) cold storage supplemented by mixing snow ice with the product. The storage treatments for carrots included cold storage and outdoor pit storage. A survey of practices employed by canners indicates a wide range in time intervals between harvesting and processing. Green beans, unlike other commodities tested, do not tend "to heat" at room temperature, and the use of snow ice is not essential in prolonged holdings. Shelled lima beans held in lug boxes in outdoor shade had temperatures 36° and 38° F. higher than air temperatures after 24 hours holding. This commodity should be hydro-cooled and placed in 32° F. storage if the holding period exceeds a very few hours.

Heavy Minerals in Some Podzol Soil Profiles in Michigan

MATELSKI, R. P. AND TURK, L. M.

Soil Sci. 64: 469-487. 1947. [Journal Article 898 (n. s.) from the Michigan Agricultural Experiment Station]

A study was made of heavy minerals in some of the northern Michigan podzol profiles in order to aid in explaining certain morphological peculiarities in these soils. It was thought that such a study would aid in revealing geological differences in the soil horizons and in determining the intensity of the weathering processes in various horizons. Two groups of podzol soils were investigated: namely, Emmet, Kalkaska, and Wallace sands, designated as group I; and Grayling, Rubicon, Roselawn, and Eastport sands, designated as group II. Members of group I were characterized by a stronger expression of the Morphological features of typical podzol profiles than were members of group II. Heavy-mineral separations were made on the fine sands and there were significantly greater amounts of heavy minerals in all horizons of the group I soils than in the corresponding horizons of the group II soils. In all the soils, the total amount of heavy minerals was greatest in the C Horizon. In most of the soils, the B Horizon had the lowest content of heavy minerals. The brown B Horizon of these podzols is the result of a vigorous decomposition of a relatively high original content of opaque and ferromagnesian minerals. Organic matter is an effective weathering agent of some heavy minerals in the B Horizons. The least resistant mineral to podzol weathering was found to be dark green hornblende, followed by graygreen hornblende, the opaque minerals, and the garnets. In general, the B Horizons suffered a greater decomposition of the heavy minerals than did the A or C

Horizons. Kalkaska and Emmet sands (soils that support a hardwood cover) contained a greater quantity of calcium and magnesium heavy minerals in all horizons of the profile than did Wallace, Rubicon, Roselawn, and Grayling sands (soils that support a pine cover). The data suggest that the intense brown B Horizon in group I soils is due to a greater amount of iron oxide organic matter and perhaps to a greater original content of the opaque and ferromagnesian minerals (and of the greater decomposition of these minerals) than in the group II soils.

The Detection and Correction of Bacterial Contamination of Milk Bottles in a Bottle Washer

BRYAN, C. S., BORTREE, A. L., AND LUCAS, P. S.

Jour. Milk Food Tech. 10 (6): 319-322. 1947. [Journal Article 899 (n. s.) from the Michigan Agricultural Experiment Station]

An instance of bottle washer contamination of milk bottles from a crate washer is described. Physically-clean milk bottles yielded bacteria counts up to 94,000 per quart bottle when this should be no more than 1,000 and usually 200 or less. Chlorination, as the final treatment in the bottle washer, yielded satisfactory bottles, although the contamination continued at the inside rinses. The installation of a vacuum breaker on the water line between the bottle washer and the crate washer corrected the combination problem. The data presented emphasize the importance of proper installation of crate and bottle washers.

A Method of Curing Farm Products by the Use of Drying Agents

DEXTER, S. T. AND CREIGHTON, J. S.

Jour. Am. Soc. Agron. 40 (1): 70-79. 1948. [Journal Article 904 (n. s.) from the Michigan Agricultural Experiment Station]

Blocks of wood and other porous materials were impregnated with suitable solutions of calcium chloride, magnesium chloride and other chemicals. These blocks were found effective in removing moisture from the atmosphere. When placed in bins of grain, etc., they continuously removed moisture from the air, thus permitting the grain to dry. With this method of reducing the relative humidity in the storage space, spoilage was prevented. Blocks may be so prepared that they will readily absorb from 50 to 100 percent of their dry weight.

Blood Studies in Dogs Following the Injection of Penicillin

BRINKER, W. O.

North American Veterinarian. 25: 31-33. 1947. [Journal Article 909 (n. s.) from the Michigan Agricultural Experiment Station]

Penicillin was administered in various vehicles, dosages, and routes of injection to determine 1) the blood plasma levels of penicillin at different intervals following its administration, and 2) the effect on the peripheral blood. Seventy-one trials were completed, using 12 normal healthy dogs.

Following a single injection of 1,000 units per pound of body weight in a vehicle consisting of 5 percent dextrose in physiological saline, the penicillin blood plasma concentration was found to be approximately the same for all four routes of injection at 30 minutes; however, the penicillin level of 0.03 unit or better was maintained approximately twice as long when the subcutaneous, intramuscular, and intraperitoneal routes were used as compared to the intravenous route.

Penicillin blood plasma levels following the administration of various doses (250, 500 and 1,000 units per pound of body weight) in 5-percent dextrose and physiological saline given intramuscularly and subcutaneously. In this series subcutaneous administration was found to be slightly superior to those following intramuscular administration both in concentration and prolongation of plasma level.

When administered subcutaneously, 5-percent dextrose in physiological saline was found to be equal or slightly superior to the water-in-oil in maintaining penicillin plasma levels. Romansky's Formula was found to excel the above vehicles, as a level of 0.03 unit or better was maintained in all cases at least 6.5 hours following a subcutaneous injection of 1,000 units per pound.

In each trial the first and last blood sample drawn was checked for erythrocyte and leukocyte cell counts, hemoglobin content, and leukocyte differential count. These data indicate that single injections of penicillin in various dosages have no immediate effect on altering the peripheral blood in the normal healthy dog.

The subcutaneous route of injection was found to be the one of choice for ease of administration, least objection on the part of the dogs, and for production and prolongation of the penicillin blood plasma level. No local or systemic reactions were noted following the injection of the various penicillin preparations used in this experiment. On autopsy of the dogs at the termination of the study no macroscopic lesions were found at the sites of injections.

Shrinkage of Spun Rayons in Hand and Machine Laundering

TEAR, J. F.

Rayon Textile Monthly. 28 (9): 83-86. 1947. [Journal Article 910 (n. s.) from the Michigan Agricultural Experiment Station]

In recent years, rayon and particularly spun rayon fabrics have replaced cottons for women's wash dresses, for sport wear and children's clothing. One difficulty with rayons—and especially spun rayons—has been dimensional change, the shrinking and stretching of fabrics. The purpose of this study was to determine the amount of dimensional change in a selected group of spun rayons when laundered by hand and by machine. The 37 spun rayons tested were purchased in Michigan in the spring of 1944.

The fabrics that were hand-laundered retained their original texture and appearance better than those that were laundered by machine. The latter looked as though they had been washed and ravelled very badly.

There was no appreciable difference in the amount of shrinkage that occurred in the hand-laundered and the machine-laundered, most of them shrinking 5-percent or more. This amount of shrinkage is so high that any garments made from these fabrics would in all probability be unsatisfactory after laundering.

Delayed Maturity of Bean Plants Sprayed with Solutions of 2,4-Dichlorophenoxy-acetic Acid of Non-herbicidal Concentrations

STROMME, E. R. AND HAMNER, C. L.

Science. 107: 170-171. 1948. [Journal Article 911 (n. s.) from the Michigan Agricultural Experiment Station]

In a study of the effect of 2,4-D on the growth and development of bean plants, it was found that their maturity was markedly delayed by concentrations of 10 p.p.m. applied just prior to flowering. Maturity was delayed from 2 to 4 weeks. Development of lateral branches from the second node of plants treated with 2,4-D just prior to flowering was a striking feature of the experiment. At harvest time treated plants carried a significantly higher number of leaves per plant and also showed a greater set of fruit.

A Chemical Control of Seedstalk Development in Celery

WITTWER, S. H., COULTER, L. L., AND CAROLUS, R. L.

Science. 106 (2763): 590. 1947. [Journal Article 913 (n. s.) from the Michigan Agricultural Experiment Station]

Premature seeding of celery (variety, Cornell 19) was prevented by spraying the young seedlings, prior to cold exposure and field transplanting, with 100 parts per million of alpha-ortho-chlorophenoxy-propionic acid. All plants sprayed with the chemical, whether subsequently exposed to cold or not, remained vegetative throughout the growing season. Similarly handled but unsprayed seedlings produced seedstalks.

A New Technique for Isolating Listerellae from the Bovine Brain

GRAY, M. L., STAFSETH, H. J., THORP, F., SHOLL, L. B., AND RILEY, W. F.

Jour. Bact. 55 (4): 471-476. 1948. [Journal Article 916 (n. s.) from the Michigan Agricultural Experiment Station]

Five cases of listerellosis in the bovine were included in this report. *Listerella monocytogenes* was isolated from the brain in only two or three cases on initial culture. After the brain suspensions which were negative on culture had been refrigerated for from 5 weeks to 3 months, all the suspensions yielded the microorganism. The exact mechanism involved has as yet not been determined but reference is made to the possibility of the presence of an inhibitory factor in the bovine brain. Identification of the cultures was confirmed by biochemical reactions and the ability to produce a conjunctivitis when installed into the eye of a rabbit. A true case of encephalitis in the rabbit resulting from ocular installation was also reported.

Storage and Treatment of Milking Machine Inflations under Farm Conditions

JENSEN, J. M. AND BORTREE, A. L.

Jour. Dairy Sci. 31 (5): 331-339. 1948. [Journal Article 919 (n. s.) from the Michigan Agricultural Experiment Station]

Farm application of milker inflation storage employing 0.5 percent lye solution, 200 p.p.m. cationic germicide and dry storage was observed through means

of farm inspection, sterile rinse counts of inflations and bacterial counts of milk. Comparison of storage treatment was made using two different procedures on each of two designated milkers on each farm.

The lye and cationic solutions seemed to have equal germicidal value as measured by total rinse counts when solution rack storage was used. The cationic germicide solution caused greater reduction in thermoduric count of rinse water samples than did lye. Lye solution had less germicidal effectiveness than the cationic germicide when immersion storage was used.

Dry storage was least satisfactory in maintaining uniformly low counts of inflations, and high thermoduric counts were associated with cold water washing followed by dry storage. Dry storage after washing and "sanitizing" with 1 gallon of 200 p.p.m. cationic solution was not satisfactory. Some objection to physical properties of the cationic germicide was registered.

Continuous and Rotation Grazing of a Legume Grass Mixture with Dairy Cows

HARRISON, C. M., WILLIAMS, G., AND FISCHER, W. N.

Jour. Am. Soc. Agron. 40 (4): 357-363. 1948. [Journal Article 921 (n. s.) from the Michigan Agricultural Experiment Station]

Two 11-acre areas of a mixture containing alfalfa, ladino clover, smooth bromegrass and timothy were grazed over a 2-year period by two lots of dairy cows as nearly alike as possible in production. One area was grazed continuously during the grazing season, the other area divided into three equal areas and grazed in a rotational manner. Volume growth differences caused by rainfall and temperature changes during the season made it difficult to set up any definite time schedule for grazing the rotation fields. The rotation fields gave the best appearance at all times during the test but the cows on the continuously grazed area produced more milk and consumed more grain. The system of rotation grazing proved neither advantageous from a production nor a management standpoint when compared to continuous grazing in this experiment. The problems involved in the management of dairy cows as test animals were much more numerous and difficult than were those when ewes and lambs were used in a similar experiment.

The Correlation of Certain Characters with Yield in Barley Strains

LEASURE, J. K., DOWN, E. E., AND BROWN, H. M.

Jour. Am. Soc. Agron. 40 (4): 370-373. 1948. [Journal Article 924 (n. s.) from the Michigan Agricultural Experiment Station]

In 1946, using 75 mildew resistant strains of barley, coefficients of correlation were obtained between plant height, length of head, strength of straw, test weight of grain and yield.

The small size of the coefficients of correlation (some were statistically significant) show that not enough of the variability in yield can be attributed to variation in any one of the factors studied to be of much value in a field selection program.

Evaluation of Some Poultry Remedies

STAFSETH, H. J.

M.S.C. Vet. 8 (11): 56-64, 86. 1948. [Journal Article 931 (n. s.) from the Michigan Agricultural Experiment Station]

This work was done at the request of the Food and Drug Administration, Washington, D. C. The purpose was to determine whether certain claims made concerning these "remedies" were true. Millions of dollars are spent by poultrymen throughout the country for worthless remedies, some of which are actually harmful when used under given conditions. The "remedies" concerned were tested under controlled condition *in vivo* and *in vitro* with the following results:

None of the experiments here reported revealed any evidence justifying the use of any of the remedies tested. They proved to be perfectly worthless; in fact, GM seemed to be harmful when given to chickens and chicks affected with pullorum disease.

Medication with the "remedies" employed in these experiments did not materially affect appetite, water consumption or body weight.

So-called intestinal astringents were tested for astringency, coagulation of protein. No results were obtained that would justify their use as "intestinal astringents".

The products, recommended as antiseptics to be used in drinking water, subjected to phenol coefficient and agar cup tests, proved to be entirely worthless.

If potassium dichromate has any value in the medication of poultry, as is thought to be the case in the treatment of pullet disease (Weisner, 1940, and Jungherr and Matterson, 1944), there is certainly no evidence supporting any claims of astringent or antiseptic action in the recommended dosage. This is also true for the other products recommended for use in drinking water and tested in the course of these experiments.

The Geneva Trade Agreements and American Agriculture

WITT, L. W.

Farm Policy Forum I. (2): 52-58. 1948. [Journal Article 932 (n. s.) from the Michigan Agricultural Experiment Station]

The tariff and trade agreements made at the Geneva International Conference on Trade and Employment were reviewed. The major tariff reductions on agricultural products made by the United States and by other countries were listed. Agreements on conditions of competition in international trade were discussed briefly.

Major attention was given to the probable effects of the tariff changes on prices of United States agricultural products. Both direct and indirect effects were included.

Relatively minor changes in United States farm prices are likely in the immediate future. In some cases, tariff reductions have led to higher prices for foreign countries selling in the United States. Over a longer period increased competition

will be felt for both agricultural and industrial goods as foreign production is restored. This competition and price effects will be somewhat larger for some farmers because of the tariff reductions.

On the other hand if the tariff agreements are followed by further efforts towards economic integration of the various national economies, the volume of international trade will remain relatively high. Farmers producing export crops, such as wheat, cotton and tobacco, and farmers selling to workers employed in industries with substantial export business, such as the automobile industry, will continue to have large outlets for their produce. Farmers and consumers will benefit from the lower prices for certain imported goods which they buy.

Functional Design of a Milkhouse

BOYD, J. S.

Agr. Eng. Jour. 147-48. 1948. [Journal Article 933 (n. s.) from the Michigan Agricultural Experiment Station]

It was necessary to analyze the various milk ordinances influencing the production of milk and determine whether or not one plan could be made to suit different markets. It was found that construction requirements could be standardized and that the most variation was in the equipment required.

There are three functions which must be provided for in a milkhouse: 1) a place where milk can be handled and stored; 2) a place where utensils may be cleaned, and 3) a place where clean utensils can be stored and kept clean between milkings.

The floor area required by ordinances, by the farmers, and by calculations, was determined and compared in graph form. Milk ordinances require more floor space than is actually needed and, from the results of the survey, it was evident that farmers were building according to the milk ordinances which required more room than was needed.

Another factor affecting the use made of the milkhouse, is the distance between the stable and milkhouse. When the milkhouse was adjacent to the stable, the farmer, in most cases, used the milkhouse as a place in which to handle his milk. The value of the milkhouse decreased as the distance from the barn increased. Plans have been prepared which will satisfy both the milk ordinance and our suggestion for good location.

Tetraethylthiuram Monosulfide for the Treatment of Mange and Allied Skin Conditions in a Dog

EADS, F. E. AND HAWKINS, P. A.

No. Am. Vet. 29 (6): 355-358. 1948. [Journal Article 936 (n. s.) from the Michigan Agricultural Experiment Station]

A 2- to 5-percent solution of tetraethylthiuram monosulfide applied to the affected area of the body two to four times at 3-day intervals resulted in recovery in most cases of sarcoptic and notoedric mange. A bland soap containing 5 percent of the compound has prophylactic but not therapeutic value when used for bathing dogs. The compound is of some value in treating demodectic mange.

Retardation of Ripening of Fruits with the Methyl Ester of Naphthalene Acetic Acid

MARSHALL, R. E., HAMNER, C. L., AND KREMER, J. C.

Am. Soc. Hort. Sci. Proc. 51: 95-97. 1948. [Journal Article 940 (n. s.) from the Michigan Agricultural Experiment Station]

Respiration rates were determined for Jonathan, McIntosh, and Northern Spy apples which had been wrapped with tissue paper, or sprayed with Geon 31X, in which was incorporated the methyl ester of naphthalene acetic acid at concentrations of 1,000 to 10,000 p.p.m. The methyl ester rather consistently retarded respiration rates when used at the lower concentrations with either of the carriers: in one test the average depression amounted to 29 percent.

Bovine Listerellosis in Michigan

GRAY, M. L., THORP, F., SHOLL, L. B., AND RILEY, W. F.

M.S.C. Veterinarian 8 (2): 83-84. 1948. [Journal Article 939 (n. s.) from the Michigan Agricultural Experiment Station]

Five cases of listerellosis in the bovine were included in this report. Some of the more prominent symptoms of the disease were discussed. Isolation of *Listerella monocytogenes* was accomplished in three cases only after the brain suspension had been refrigerated.

Effect of Wax Sprays on the Yield of Cherries, Pears and Apples

LANGER, C. A.

Am. Soc. Hort. Sci. Proc. 51: 191-195. 1948. [Journal Article 941 (n. s.) from the Michigan Agricultural Experiment Station]

Dowax 222 was applied at the concentration of 1 percent to cherry trees when fruits were starting to turn red and again seven days later. The wax spray reduced the transpiration of the tree and apparently increased in weight by 7½-24 percent. The wax emulsion showed no visual ill effects on the tree or fruit. Quality of fruit was equal to the check trees. The variability in increase in weight can be attributed to the wide variation in red cherry strains and to the varieties of sweet cherries used. The author used the same concentration of spray on pears and apples, the Bartlett pear responded favorably, but the Kiefer pears and apple varieties were negative in their response. Ten to sixteen percent more Bartlett pears attained the 2¼-inch size compared to the check trees.

The Use of Intramedullary Pins in Small Animal Fractures

BRINKER, W. O.

North American Veterinarian. 29: 292-297. 1948. [Journal Article 943 (n. s.) from the Michigan Agricultural Experiment Station]

Intramedullary pins were used in the fixation of fractures of the femur, tibia, and mandible of young dogs and cats.

Locations and insertion of the Steinman pins in the various bones was discussed. Transverse fractures were found to be more adaptable for intramedullary pin fixation than other types. The Gordon Extender and open reduction were used to advantage in accomplishing end-to-end alignment which was necessary for insertion of the pin. The main advantages for this method of fixation are tolerance of the animals to intramedullary pins, healing time, and functional results.

Colorfastness of a Selected Group of Spun Rayons

TEAR, J. F.

Jour. Home Economics. 40 (5): 259-260. 1948. [Journal Article 961 (n. s.) from the Michigan Agricultural Experiment Station]

Widespread use of spun rayon fabrics for women's dresses, sportswear, and children's clothes has stimulated consumer interest in the colorfastness of such fabrics. A selected group of spun rayon fabrics was studied 1) to determine the degree to which they were colorfast to light, to laundering by hand, to crocking, and to perspiration and 2) to learn whether or not any relationship existed between the colorfastness of these fabrics and the prices paid for them. Laboratory tests were conducted to determine colorfastness to light, to perspiration (both acid and alkali), to crocking (wet and dry), and to laundering. After laundering, specimens were checked for bleeding and fading.

On the whole, the fabrics rated highest on their resistance to crocking; three percent crocked when dry and eleven percent when wet. About one-third faded when laundered and more than one-third bled excessively. Thirty-eight percent could not be expected to give satisfactory service when exposed to sunlight. Colorfastness to perspiration was poor; forty-six percent were not colorfast to acid perspiration, and only 43 percent were not colorfast to alkaline.

No consistency was found among ratings in a given price group as to the colorfastness of the fabrics under different conditions, such as light, laundering, crocking, or perspiration. The lowest priced fabrics averaged the highest in colorfastness to light and faded the least when washed, in fact they were colorfast to more tests than any one group. On the other hand, the highest priced fabrics rated the lowest on colorfastness to light and the highest on resistance to crocking. One group averaged high in one respect and low in another. Since a fabric may be colorfast under some conditions, and not under others, any guarantee of colorfastness should state the conditions under which it is colorfast, i.e., to washing, light, perspiration, or to all of these.

Studies on the Morphological and Physiological Characters of a New Species of the Genus Paecilomyces

HSIE, JEN-YAH, JUBB, ANNANELL C., AND STAFSETH, H. J.

Soc. Am. Bact. Proc. 1 (1): 43-44. 1948. [Journal Article 964 (n. s.) from the Michigan Agricultural Experiment Station]

This work was done for the purpose of identifying an organism which had been found to be present in the blood, spleen and kidneys of rats in the stock colony of the Department of Foods and Nutrition. The possibility that it was

responsible for low fertility in rats in the stock colony had been expressed. No gross pathological manifestations had been observed. In tissues the organism resembled certain protozoa. The organism was maintained on cornmeal agar medium, and the following media were used for cultural and morphological studies: Sabouraud broth, modified Sabouraud agar, Czapek medium, nutrient broth, beef extract agar and carrot slants. Growth was studied in slide culture using modified Sabouraud medium and Czapek medium. Physiological characteristics were studied in the usual manner. It produced acid but no gas in dextrose and maltose and hydrolyzed starch. No fermentation took place in sucrose, lactose, mannitol, salicin, xylose, inositol arabinose, dulcitol and rhamnose. Gelatin was not liquefied. The pigment of its gonidia is soluble in ether, insoluble in chloroform, benzene, alcohol and distilled water. Its optimum temperature is approximately 37°C. for 10 minutes in dry heat. It survived desiccation for 40 days. It was identified as a new species of the genus *Paecilomyces* for which the name *Paecilomyces michiganensis* is proposed.

The QUARTERLY BULLETIN

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CONTENTS

(Continued on Next Page)

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: (1) progress reports on long-term major research projects; (2) final reports on short-term projects and (3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

CONTENTS

(Continued from Outside Front Cover)

THE VACCINAL IMMUNIZING VALUE OF A MUCOID-GROWTH PHASE OF *Brucella suis* AGAINST BRUCELLOSIS IN CATTLE

By I. FOREST HUDDLESON and G. R. BENNETT
SECTION OF BACTERIOLOGY AND PUBLIC HEALTH

PREVENTION of brucellosis in cattle has challenged the minds of investigators for a half century. Its eventual eradication depends upon the effectiveness of preventive methods as well as removal of infected animals. If there were available an immunizing agent that could be used on adult cows as well as on young calves without creating additional complex problems, the eradication of the disease would be greatly accelerated.

A suitable immunizing agent should meet the following requisites: a) it should not be harmful, that is, it should not produce a progressive type of disease or establish a carrier state in the species of animal in which it is injected; b) the agent should not cause the production of specific serum agglutinins that persist for more than 3 or 4 months and thus increase the difficulty of distinguishing infected animals from those not infected by means of the agglutination test; c) it must engender sufficient immunity in susceptible animals to prevent the spread of the disease in herds while infected ones are being eliminated, and to prevent its introduction into herds where infected ones are absent. With those objectives in mind, a solution to the problem of developing a suitable immunizing agent was sought through a study of the dissociated growth phases of the species of *Brucella*. Many of the dissociated growth phases of *Brucella* have already been identified and studied (1), (2).

In the course of an investigation (3) of the immunizing value of each of several mucoid growth phases of the species of *Brucella* against experimental brucellosis in the guinea pig, it was noted that one mucoid-growth phase of *Brucella suis*, when prepared in the form of

ARTICLE 31-14

a vaccine and injected into guinea pigs, produced a higher degree of immunity against infection with all three species than the others.

The term "mucoid" defines one of the growth characteristics of certain dissociated phases of the species of *Brucella.* The visible growth on culture media has the consistency of mucus or soft wax.

Since all three species of *Brucella* have been recovered from cattle in the United States, and since there is a possibility that careful bacteriological examinations may reveal a wide distribution of *Brucella suis* and *Brucella melitensis* as well as *Brucella abortus*, it would seem desirable to have available a safe *Brucella* vaccine capable of engendering in cattle sufficient immunity to protect them against infection by the three known species of this organism.

Repeated trials have shown that live organisms of the mucoid strain in question, when injected into guinea pigs in numbers varying from 10^9 to 5×10^9, do not produce a progressive type of disease such as is produced by most strains of the S-phase.

Before attempting to determine this strain's immunogenic value in cattle, it was considered desirable to determine whether the injection of a large number of bacterial cells of the strain into non-pregnant heifers produced active infection and abortion.

Fresh suspensions containing 10^{10} live organisms and approximately the same number of non-viable ones (approximately 2.5 mg. dry weight) were injected subcutaneously into seven heifers. Of these, four were given one injection; two were injected at 1 month, one at 4 months, and one at 5 months after conception. Each of three others received two injections; two were injected 4 months before and again 1 month after conception, and one other, 2 and 4 months after conception. All of the animals gave birth to normal calves without retention of placentae. There was no evidence obtained from an examination of the milk and placentae of the animals which would indicate that mucoid phase organisms were present. The blood serums of all animals became negative to the agglutination test within 90 days after injection of the vaccine and remained so up to the time they were disposed of, several months after calving. As far as one could determine, the animals were not exposed naturally to pathogenic *Brucella* organisms during the period of observation.

After demonstrating that a large number of cells of the mucoid strain of *Brucella suis* caused no harmful effects after injection into pregnant heifers, it was considered of at least academic importance

to determine whether a vaccine made of the mucoid strain and injected into young or adult cattle brought about any degree of resistance against *Brucella* infection. It was obvious that such a determination would have more significance if it were made on a sufficient number of animals under well-controlled conditions. In other words, an equal number of unvaccinated animals should have been subjected to the same degree and the same method of exposure as those that received the vaccine.

Since a cattle housing shortage prevented the use of a sufficient number of animals for conducting such a controlled experiment, it was decided to learn as much as possible about the immunizing value of the vaccine in negative-reacting animals in privately owned herds, in which infected animals had been present for only a short time. Experience (4) has shown that it is next to impossible to evaluate the protective action of a vaccine in animals in privately owned herds where the disease has been present for one year or more. This is because only a slightly higher percentage, if any, of the negative unvaccinated controls become infected during the period of observation.

If, after the injection of the *Brucella* mucoid vaccine into all supposedly non-infected adult animals in a large number of herds in which the presence of infected ones was of recent date, the further spread of brucellosis were limited to a small number of animals in each of the herds during the following year or longer, it would be logical to attribute the lack of infection to an active immunity engendered by the vaccine.

It has been demonstrated many times that when brucellosis enters a herd in which no infected animals have been present for several years, it is not always easy to stop the spread of the disease by removing the first animals in which infection has been detected. This is because an infected animal may abort while in pasture with others and before her presence has been detected by means of the blood test.

The immunizing value of many widely accepted vaccines and bacterins that are used to combat the spread of infectious diseases in human beings has not been arrived at through well-controlled experiments. However, their use has been approved by recognized health agencies. Today, no health official would fail to recommend their use to susceptible individuals who live in or visit areas where the diseases are endemic. The immunizing value of the agents in question was arrived at through controlled experiments in animals and by injecting large numbers of susceptible human beings in endemic areas.

EXPERIMENTAL PROCEDURES AND RESULTS

The vaccine used in the field studies was prepared in 1-liter amounts of fortified tryptose liquid medium. The inoculated medium was placed in a shaker and incubated at 37° C. for 72 hours. During the period of incubation, a stream of O_2 at a flow rate of 25 ml./min., was passed into the space above the medium. At the end of the incubation period, a sample of the cell suspension was removed from the bottle and examined for purity, dry weight of cells per ml., and live cell count per ml. As a rule, the medium employed will produce 2.5 to 3 mg. of cells/ml. (dry weight) in 72 hours. It was not possible to arrive at an accurate live cell count of this growth phase because of the rapid clumping and settling of the cells, but as nearly as could be determined by plate colony count the number varied between 6×10^9 and 10^{10}/ml.

The bacterial cell suspension was vialed and stored at 4° C. Each lot was used within 1 month after preparation. Viability studies have shown that a 10-percent reduction in the number of viable cells usually occurs during a storage period of 3 to 4 months at 4° C., or of 8 days at 25° C. Previous immunization studies with the mucoid phases (3) in guinea pigs have shown that the degree of immunity produced is related more to the weight of cells injected than to the actual number of live cells. For that reason the size of the vaccine dose used in this study was based on dry weight of cells rather than the number of viable cells.

A single injection of the vaccine, varying from 2.5 to 5 mg., was administered subcutaneously to each animal regardless of age. As a rule, the same amount was injected into all animals in each herd. As the field study progressed, it was noted that more of an indurated swelling was produced when the vaccine was injected into an area just anterior to the scapula than one just posterior to this region. Therefore, vaccine was administered in the area in which the least localized swelling developed.

In certain herds, the vaccine was injected into calves 2 months old and older, as well as into all adult females in various stages of gestation. A small number of immature and mature bulls also were injected.

The chief criterion used to determine the absence or presence of brucellosis in the animals before and after the injection of the vaccine was the serum agglutination titer of each animal. All the animals were

bled and tested on the day of, or a short time before vaccination and at intervals of 3 to 4 months during the period of study. In certain herds the animals were bled and tested at weekly or monthly intervals after injection in order to observe the rise and fall in the agglutination titer.

The agglutination test is considered a reliable indicator of *Brucella* infection in cattle even though it has certain recognized limitations. If this test is reliable enough to be used by agencies as the sole means of detecting *Brucella*-infected animals, in order to control and eradicate the disease in herds of cattle, then there is justification for using it to identify those animals that become infected after they have been injected with a *Brucella* vaccine that does not cause the development of specific serum agglutinins to the extent that diagnosis of the disease is obscured. Of coure, someone might raise the question, "Does the injection of the vaccine bring into action in the body some unknown mechanism which actually prevents the development of specific agglutinins when an animal becomes infected with a naturally occurring strain of *Brucella?*" Such an action cannot be completely ignored, but up to the present time no evidence has been obtained which indicates that the appearance of specific agglutinins in the serums of infected animals is being prevented.

Whenever possible, aborted fetuses were obtained from the injected animals that aborted and were examined for the causative agent. Milk samples from animals in certain herds were examined at different periods after injection, chiefly for the presence of the vaccine strain of *Brucella.*

It is rather difficult to present a clear picture in condensed tables of all the data that were recorded on all animals in each of the 24 herds in which the immunizing capability of the *Brucella* mucoid vaccine was determined. However, the writers have attempted to present the involved records of each herd in as condensed space as is possible, and in such a form that the reader should be able to obtain a clear picture of the course of the disease observed in the herds before and after the injection of the mucoid vaccine.

Changes in the serum agglutination reactions and the number of abortions that occurred in the reacting, suspicious, and negative animals of breeding age in each of the 24 herds during a 12- to 14-month period before and after they were injected with the mucoid vaccine are recorded in Table 1. The results that were obtained in all the herds are grouped together and summarized in Table 2.

RESULTS OF INJECTING MUCOID VACCINE INTO REACTING AND SUSPICIOUS REACTING ANIMALS

When the field studies of the mucoid vaccine were begun, there was no reason to believe that its injection into reacting and suspicious reacting animals would bring about any change in their status toward the disease. Since most of the owners were encouraged to keep the initial reactors and suspicious animals in their herds, in order to have an infection source for challenging the negative ones that were vaccinated, it was thought that this would be an opportune time to determine whether the injection of this type of vaccine influenced the course of the disease. No animals in the two groups were left untreated. During the period of observation, 44 of the 197 initial reactors and 16 of the 158 initial suspects in all the herds were sold or died. The total number of abortions, 34, recorded in the reacting animals does not present a true picture of abortion incidence in this group. A considerable number of these aborted during the year prior to the time they were injected with the vaccine. For example, in herds No. 3, 8, and 12, there were respectively 7, 13, and 12 abortions in the reacting animals during the year prior to the injection of the vaccine.

Before the end of a 14-month period, the blood serums of 44 of the initial reactors were showing either no reaction or a suspicious reaction to the agglutination test. The decrease in the agglutination reactions shown by the animals in certain herds may not be of any significance. If the vaccine caused a reaction to take place in the tissues which lowered the agglutination titers of the reactors, one would expect to find a similar action taking place in a few of the reactors in all the herds. That this did not occur is evident from the data recorded on each of the herds in Table 1. There were no changes from a reactor to a suspicious or to a negative status in such animals in many herds.

It was, however, surprising to find that 39 percent of the initially suspicious animals reverted to a negative status, and only 17 percent became reactors during the period of observation. There is still a question in the minds of the writers as to whether the injection of the vaccine was responsible for the decrease in the blood serum reactions that were recorded in this group.

A partial answer to the question of how many reacting and suspicious reacting animals normally revert to a negative status was obtained several years ago by Huddleson and Smith (5) in a study of

TABLE 1—*Status of Brucella agglutination reaction in 24 herds of adult female cattle before and during a 12- to 14-month period after the injection of Brucella M vaccine*

	Herd number																					
	1	2	3	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Total animals in each herd	34	13	33	17	22	169	92	37	35	76	17	115	72	55	76	18	15	30	27	112	28	34
Reactors	0	1	13	2	0	31	45	18	19	26	3	1	5	11	11	1	1	2	2	2	2	1
Reactors becoming suspects	0	0	0	0	0	2	10	1	5	4	0	0	0	1	0	0	0	0	0	0	0	1
Reactors becoming negative	0	0	0	0	0	4	2	5	3	1	2	1	0	1	0	0	0	0	1	0	0	0
Number sold or died	0	0	13	2	0	4	0	0	0	0	1	0	1	5	11	0	1	2	0	2	2	0
Reactors remaining	0	1	0	0	0	21	33	12	11	21	0	0	4	4	0	1	0	0	1	0	0	0
Number of abortions	0	0	6	0	0	5	0	6	2	12	0	0	0	1	1	0	0	1	0	0	0	0
Suspects	2	0	3	1	1	14	22	12	6	30	2	6	10	6	11	1	0	3	1	23	2	2
Suspects becoming reactors	1	0	2	0	0	3	2	5	1	3	0	0	2	0	1	0	0	3	0	2	1	1
Suspects becoming negative	1	0	1	0	0	8	6	5	1	2	2	6	4	5	4	1	0	0	1	15	0	0
Number sold or died	0	0	0	1	1	1	0	0	0	0	0	0	1	0	6	0	0	1	0	4	1	0
Suspects remaining	0	0	0	0	0	2	14	2	4	25	0	0	3	1	0	0	0	0	0	2	0	1
Number of abortions	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	0	2	0	0	0	0
Negatives	32	12	17	14	21	124	25	7	10	20	12	108	57	38	54	16	14	25	24	87	24	31
Negatives becoming suspects	0	0	1	0	0	2	8	0	3	5	0	0	1	0	1	0	0	1	0	3	0	0
Negatives becoming reactors	0	1	4	0	0	8	1	0	1	0	0	0	0	0	1	1	0	1	0	3	0	2
Number sold or died	4	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	2	0	19	5	6
Negatives remaining	28	11	12	14	21	111	16	7	6	15	12	108	56	38	52	14	14	21	24	62	19	23
Number of abortions	0	0	4	0	0	5	0	1	0	2	0	9	1	2	2	0	1	1	0	5	0	0

the trend of the serum agglutination titers of animals in a large dairy herd. Of a total of 189 showing an agglutination titer of 1: 100 or higher, and of 85 showing a positive reaction in dilutions less than 1: 100, 8 percent and 31 percent, respectively, reverted to a negative status during a 4- to 6-year period. The data obtained in this large herd would suggest that the decreases recorded in the blood reactions in the animals in the 24 herds might have taken place naturally.

RESULTS OF INJECTING MUCOID VACCINE INTO NEGATIVE ANIMALS

When one injects a *Brucella* vaccine into negative animals in herds in which brucellosis has been present for only a short period of time, in order to determine its value in preventing the spread of the disease, one is not always sure, on the basis of one blood test, that all negative animals are free from infection at the time. It has already been demonstrated by McEwen and associates (6) and by Bendixen and Blom (7) that more than 200 days may elapse before cattle show a significant agglutination titer after a known exposure to *Brucella abortus*.

It was, therefore, not surprising to find 23 negative animals in a few of the herds showing evidence of infection after the injection of the vaccine. Most of these occurred within 3 to 4 months after injection. The 684 animals that remained negative during the entire period of observation had associated with and had been exposed to 247 reactors, in all three groups. Since 49 of these aborted, supposedly because of *Brucella abortus* invasion of the pregnant uterus, it is logical to assume that many of the animals that remained negative to the blood test had an opportunity to come in close contact with the aborters and be subjected to exposure to a considerable number of *Brucella abortus*.

Although Table 2 shows that 684 of initially negative animals remained negative to three or more agglutination tests after vaccination, this figure does not include 18 others that were sold as bred heifers after being in the herds for varying lengths of time. Since no unvaccinated negative animals were left in these herds as controls, the question might be raised as to whether all the negative animals would have remained negative without the injection of the vaccine. It is possible that many of the animals in certain herds in which no abortions occurred during the year or more of observation would have remained negative because of the lack of an opportunity to be exposed to infec-

TABLE 2—*Summarized status of brucellosis in all adult animals before and during a 12- to 14-month period after injection of M vaccine*

Total of all animals	1,127	Percent of initial number
Reactors, initial	197	
Reactors becoming suspects	24	12+
Reactors becoming negative	20	10+
Number sold or died	44	
Reactors remaining	109	
Number of abortions	34	
Suspects, initial	158	
Suspects becoming reactors	27	17
Suspects becoming negative	62	39
Number sold or died	16	
Suspects remaining	54	
Number of abortions	6	
Negatives, initial	772	
Negatives becoming suspects	25	3+
Negatives becoming reactors	23	2.9
Number sold or died	40	
Negatives remaining	684	
Number of abortions	33	

tive organisms. However, from observations of the rapid spread of brucellosis in herds that had been free from it for several years, it does not seem possible that such a large number of animals would have continued to remain negative in herds of a similar status if the injection of the mucoid vaccine had not increased their resistance to infection.

Three herds observed during this investigation illustrate the rapid spread of the disease in animals that had never received vaccine of any type. One of the herds consisted of 41 adult purebred Guernseys. The first reactor that appeared in the herd was removed. During the following 12 months, 24 of the previously negative animals became reactors and 14 of these aborted. Another herd consisted of 24 grade Holsteins which had been negative for a number of years. Six months after a negative test on all animals, the animals were again tested. This time, 20 of the 24 were found to be reactors. During the interval between tests, two animals had aborted. Within 8 months after brucellosis had entered another negative herd containing 70 adult purebred Holsteins, 45 of the animals had become reactors.

There was obtained in one small herd of dairy cattle not included in Table 1 some indication of what might have been the fate of unvaccinated controls if they had been left in many of the herds included in Table 1. The owner expressed his willingness to take a chance of

sacrificing half of the negative animals to determine the immunizing value of the mucoid vaccine under controlled conditions.

The herd consisted of 16 grade Holsteins of breeding age. As nearly as could be determined, the first evidence of the presence of brucellosis was the occurrence of two abortions in November 1947, about 10 days apart. A blood test on all animals, 4 days after the second abortion, revealed five reactors. A few days after the blood test, five of the negative animals were injected with the mucoid vaccine and six others were left as controls. Within a 7-month period after vaccination, three of the controls became reactors, but the five vaccinated animals remained negative.

Of course it would be ridiculous to draw conclusions as to the immunizing value of the vaccine from results on so small a number of animals. The results are indicative, however, of the different directions the disease takes in vaccinated and unvaccinated negative animals in a herd in which the disease has been present for only a short period of time.

The disease had been present for approximately 2 months in herds No. 3 and 12 and, judging from the number of initial reactors that were found at the time of vaccination, was spreading rapidly. Of the 13 animals in herd No. 3 found to be reactors on the initial test, seven had aborted within a 30-day period prior to the test. The remaining six reactors aborted within 4 months after vaccination. In addition to these, the four negative vaccinated animals which became reactors also aborted. It is surprising that a greater number of negative animals did not become infected during the period of observation. In herd No. 12, eight of the twelve abortions occurred within 60 days prior to vaccination. Of the abortions that were recorded in the negative animals that became reactors, seven occurred within the first 4 months after vaccination. It is possible that these animals were already infected at the time of vaccination.

Herd No. 8, listed in Table 1, had been free from *Brucella*-infected animals for a 10-year period until 1 year prior to the beginning of the vaccination study. During this 1-year period, from one to six reacting animals a month were removed from the herd. The total came to 36 before the vaccine was used. Approximately 4 months after all animals (negative and reacting) were injected with the vaccine, 31 of the reactors were returned to the main herd. During the first 6-month period after vaccination, eight of the negative animals became reactors

of which five aborted. Five of the original reactors also aborted during the year.

While the study was in progress in this herd, 23 negative, pregnant heifers from a herd in which no *Brucella*-infected animals were present, were injected with the mucoid vaccine and immediately placed in the herd with the infected animals. No form of segregation was practiced. More than 1 year has passed since the heifers were placed in the herd, yet none of them has aborted or become a reactor.

Most of the abortions that occurred in herd No. 14 were of a peculiar nature. Seven were carried to the full gestation period and died within a few minutes after delivery. On autopsy, a bloody-serous exudate was found in the thoracic and peritoneal cavities. Small petechial hemorrhages could be seen on the surfaces of the spleen and lobes of the lung. *Vibrio fetus* was seen in strained smears and cultured from the stomach exudate of one fetus. No organisms were found in the others.

The course of brucellosis in herd No. 15 is of interest because of differences in incidences of infection before and after the animals were injected with mucoid vaccine. This herd consisted of purebred Jerseys and Ayrshires. For several years prior to vaccination, blood tests had been made on the animals at intervals of 1 or 2 months. The new reactors as they were detected were removed from the herd. The blood test made March 3, 1947, revealed six reactors. Approximately 1 month later, 17 new reactors were found in the herd. All animals were vaccinated April 24, 1947. At this time the blood test revealed five additional reactors and 10 suspicious reactors. These were not removed from the herd immediately. During a 14-month period after vaccination only one of the 57 initially negative animals developed a suspicious blood reaction. One negative animal aborted a 6-month fetus, 4 months after vaccination. There was no change in the agglutination titers of the initially positive animals. Of those showing a suspicious titer, four became negative and two became positive.

The status of brucellosis in herd No. 20 before and at the time the animals were injected with the vaccine is of considerable interest, because the same situation will be encountered in many other herds in which the disease has just begun to spread prior to vaccination. A blood test conducted on all animals 13 days prior to vaccination, revealed one reactor and one suspicious reactor. The reactor had aborted a 6-month fetus, 2 months before the test was made. A second

blood test on all animals the day of vaccination revealed three new suspicious reactors, the previous suspicious reactor had now become a reactor. One of the suspicious reactors aborted 15 days after vaccination, and another 6 weeks later. Bacteriological examinations showed that both were due to a naturally occurring strain of *Brucella abortus*. The third one in this group, as well as the two that aborted, became a reactor 30 days after vaccination. One animal in the negative group aborted a 9-month fetus, 4 months after vaccination. No microörganisms were found in the fetus. This animal has remained in the herd and has never shown a suspicious reaction to the agglutination test. Milk examinations were made on all animals in lactation at 30-day intervals for 5 months after vaccination. Only two of the reactors showed *Brucella abortus* in the milk and positive reactions to the agglutination and "ABR" ring test. The negative adult animals in this herd had many opportunities to be exposed to *Brucella abortus* during the period of observation. They had associated with five reactors, three of which aborted either in pasture or while housed in the barn. Only one animal in this group have thus far become a reactor. This one was detected 30 days after vaccination. If all the animals in this herd which were considered free from brucellosis on the basis of the results of the first blood test had been injected with the vaccine without making another test at the time, it would be natural to conclude that three negative animals became infected after vaccination; or that the two abortions were caused by the vaccine, since they occurred shortly after its injection.

In addition to the 24 herds listed in Table 1, the mucoid vaccine was injected into 14, 8, and 51 adult animals in three separate herds in which there were no reacting or suspicious reacting animals. In the herd containing 51 animals, five had aborted during the year prior to vaccination. Two of these occurred during the month before vaccination. No examination was made of the fetuses to determine the cause of the abortions. Since the date of vaccination, three additional animals have aborted. Two of these fetuses were examined bacteriologically, but no organisms were found. There have been no abortions in the other two herds. During the 12-month period since vaccination, none of the animals in the three herds has become a *Brucella* reactor.

There were 216 calves between the ages of 4 and 11 months in the herds containing reacting adult animals that were also injected with the vaccine. At the end of a 12- to 14-month period of observation,

none of these had shown a positive or suspicious reaction to the agglutination test.

There were no examinations made of placentae from any of the animals in the herds that calved normally or aborted. This was unfortunate and will naturally cause much justifiable criticism of the entire study.

The breeding records of the animals that were obtained from the owners of the 24 herds for one year prior to and for a 12- to 14-month period after vaccination do not show that the injection of mucoid vaccine had any adverse effects on the fertility of the animals. The service records from herds No. 8, 15, 18, and 22 show that four or more services were required in a small number of vaccinated animals before conception occurred. It is doubtful whether the injection of the vaccine was the contributing cause of infertility.

Aborted fetuses were obtained from four of the initially positive, five of the suspicious, and 14 of the 33 initially negative animals that aborted after vaccination. It was not possible to obtain the other fetuses because of the distance of the herds from the laboratory. All of the fetuses from the initially positive and suspicious animals showed *Brucella abortus* (anaerobic) on culture examinations. Of the 33 animals in the initially negative group that aborted during the 12- to 14-month period of observation following vaccination, nine became reactors either before or after aborting. Only one fetus of the nine was examined for microörganisms. *Brucella abortus* was recovered. The remaining 24 that aborted continued to show a negative agglutination reaction at 3- to 4-month intervals during the year. Fetuses from 14 of these were cultured for microörganisms. Twelve proved to be sterile and two showed *vibrio fetus. Vibrio fetus* was cultured from one aborted fetus from a negative animal in herd No. 17 at a time when there were *Brucella* reactors present. It was also recovered from three out of four aborted fetuses 1½ years after *Brucella* infection was eliminated from the herd.

The failure to find a causative agent in aborted fetuses from the non-reacting animals has not been an unusual occurrence. Several aborted fetuses, nine from one herd alone, from animals in herds that were not injected with mucoid vaccine have been examined during the past 3 years without finding a causative agent.

During the course of the study of the effect of the mucoid vaccine on animals in the privately owned herds, milk samples were obtained

from 10 negative (serum agglutination) animals in one herd 2 days after the injection of the vaccine, and from 20 others in another herd 6 days after injection, and were cultured for *Brucella* organisms. The culture results were negative on all samples. From 19 negative and two positive animals in another herd, milk samples were collected and examined bacteriologically for *Brucella* organisms at 30-day intervals for 5 months. Only the two positive animals showed *Brucella abortus* in the milk samples. Agglutination tests and the "ABR" ring test were also made on the milk samples. Again, only the samples from the positive animals were positive to both tests.

In order to obtain information on the effect of the injection of the vaccine on milk production in lactating negative animals, the daily weight of milk produced by 38 animals in one herd was recorded for 10 days just prior to injection and daily for the first 10 days after injection. A similar record was kept for 6 days on five lactating animals in another herd. The 38 animals in the first herd produced a total of 33 pounds less milk during the 10-day period after vaccination than was produced during the 10 previous days. The lowest total daily production of the 38 animals in the first herd before vaccination was 1,480 pounds. The lowest daily post-vaccination production, 1,445 pounds, occurred on the eighth day and the highest, 1,531 pounds, on the first day. The five animals in the second herd produced a total of 54 pounds less milk during the 6-day period after vaccination than was produced during the six previous days. One might conclude from these data that the injection of the vaccine into lactating cows causes a slight decrease in milk production, based on weights recorded over a period of several days. The decrease, however, based on single daily averages for a 6- to 10-day period was not always as low on certain days after vaccination as on certain days before vaccination.

DISCUSSION

The mechanism of the immunity produced by the vaccine made from cells of the mucoid-growth phase has been investigated both in laboratory experimental animals and in cattle. Most of those who have devoted considerable time to a study of immunity in brucellosis agree that the production of specific serum agglutinins and their constant presence is not necessarily an index of active immunity. In other words, a very high degree of immunity in animals or in human beings can be demonstrated when agglutinins cannot be demonstrated in serum dilutions of 1:20 or higher. Even though agglutinating anti-

bodies may not be present in the blood serum following the injection of the mucoid vaccine, one can demonstrate, however, by an *in vitro* method serum antibodies of a bactericidal or bacteriostatic nature and often in a high titer.

The writers have also demonstrated that non-infected cattle, after being injected with the mucoid vaccine, develop a high degree of skin sensitivity to a subsequent skin test dose of mucoid organisms. The sensitivity test is made similarly to the tuberculin test and read 48 hours later. Reacting cattle, as a rule, show no localized reaction to this type of allergen. It has not been determined whether the vaccinated, negative animals also develop skin sensitivity to an allergen made of S-phase cells or a product made from S-cells.

In view of the fact that serum agglutinins for an S-phase antigen can only be demonstrated in a low titer and for a relatively short period of time in cattle that have been injected with the mucoid vaccine, the thought has been advanced that if mucoid-phase antigen was employed, agglutinins could possibly be detected in a high titer. If agglutinins for a mucoid-phase antigen are produced in vaccinated animals, it has not been possible to detect them, because the antigen is agglutinated by serums from normal as well as *Brucella*-infected laboratory animals and cattle in dilutions as high as 1:1,280.

Another question which will be raised if the mucoid vaccine is used for large-scale immunization of cattle is, "Will this mucoid phase of *Brucella suis* revert to a virulent S-phase after injection into cattle?" Such a reversion is quite likely to be considered as a reality if the vaccine is ever injected into animals in a herd in which there are animals infected with *Brucella suis*, and this is not discovered until after administration. It would be unwise to say that this mucoid phase will never revert to a virulent S-phase. The fact that it has not occurred during 5 years of study of the culture, either by cultivation in laboratory media or passage through experimental animals, would indicate the possibility of reversion is highly remote.

It is known that cultures of this particular mucoid-growth phase will, when permitted to stand at room temperature for 10 days or longer, gradually put forth colonies of another dissociated phase that are S-like in appearance. Henry (1) has identified this phase as SR. When a mixture of colonies of this phase and the S-phase are examined by oblique-reflected light, one cannot be distinguished from the other. The most satisfactory method for distinguishing the two phases is the acriflavine agglutination technic described by Braun (8). A colony

is picked up by means of a very small wire spatula and suspended in a drop of a 0.1-percent aqueous solution of acriflavine placed on a microscope slide. If the colony is of the S-phase, the organisms remain uniformly suspended. On the other hand, if it is the SR-phase the cells are agglutinated instantly by the dye.

The SR-phase can easily be prevented from occurring in a culture of the mucoid phase by transferring the stock culture at short intervals. Even though it makes its appearance during the production of large volumes of vaccine, its presence is not harmful. The injection of large numbers of cells of this phase into guinea pigs and into cattle failed to produce a progressive type of *Brucella* infection.

Another mucoid phase from *Brucella suis* which has different colonial characteristics and a markedly different dissociation pattern is now being investigated for its immunizing value against brucellosis in cattle. A vaccine made from this phase will produce as high a degree of immunity in guinea pigs against *Brucella* infection as does the mucoid-phase vaccine used in this study.

The vaccine made of mucoid phase, *Brucella suis* cells will hereafter be spoken of as "Brucella M vaccine."

SUMMARY

The subcutaneous injection of 10^{10} live cells of one of the mucoid-growth phases of *Brucella suis* into non-pregnant and pregnant heifers, and adult cows does not seem to produce a progressive type of infection. In other words, no bacteriological evidence has been obtained which indicates that organisms of this growth phase establish themselves in the tissues of cattle.

When non-infected adult cattle or calves are injected subcutaneously with 10^{10} live cells of the mucoid-growth phase, the live cells do not cause blood serum agglutinins to develop for an S-phase antigen in a titer higher than 1: 100. As a rule, specific agglutinins in a titer of 1: 25 cannot be demonstrated in the serums of the animals 90 days after injection.

Live cell suspensions of the mucoid-growth phase have been prepared in the form of a vaccine. The vaccine has been injected subcutaneously into adult, pregnant and non-pregnant cattle in 24 privately owned herds to determine its capability of engendering an active immunity against brucellosis.

Each of the 24 herds contained animals showing serological evidence of brucellosis, and in most of them, infected animals had been present only a short time before the vaccine was administered.

Of the 772 adult animals in the herds that were negative to the agglutination test at the time of the injection of the mucoid vaccine, 23 became reactors and 25 suspicious reactors during a 12- to 14-month observation period. There were 33 abortions in this group. Only 9 of 33 aborting animals became positive reactors.

The effect of the mucoid vaccine on the course of the disease was determined in 197 positive reacting, and 158 suspicious reacting adult animals in the 24 herds used in this study. Forty-four of the positive animals were sold before the end of the year after injection. Of the 153 that remained in the herds, 20 became negative to the agglutination test before the end of one year. Of those that showed a suspicious reaction on the initial agglutination test, 62 became negative and 27 became reactors during the period of observation. The disappearance of agglutination titers in animals in these two groups may not have any significance insofar as the injection of the vaccine is concerned.

The mucoid vaccine was injected into 73 adult animals in three herds containing no reacting or suspicious reacting animals. At the end of a one-year period all were showing negative reactions to the agglutination test.

There was noted a slight, but not significant, reduction in the milk flow of lactating animals shortly after the injection of the vaccine.

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THE TRACTOR AS AN EMERGENCY SOURCE OF VACUUM FOR MILKING MACHINE OPERATION

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A SURVEY indicates that approximately 45,000 miles of electric lines serve 165,000 Michigan farmers, of whom many operate electric milking machines. In most cases the source of generation is several miles from the farms served; therefore, it is sometimes difficult for the utilities to maintain continuous service to each farm.

When a power failure occurs, affecting dairy farmers, the authors suggest a temporary method for supplying the required vacuum for the milker. The farm tractor is capable of developing at the intake manifold a vacuum expressed as 18 to 22 inches of mercury. In the laboratory four individual milkers were operated at one time with one tractor. The proper vacuum and rate of pulsations were maintained for all units.

Under actual milking tests, when electrical lines to the milker were disconnected and the above-mentioned method used, it was found that with little added work the farmer was able to milk in the same time normally required. During these tests only two units were used at a time.

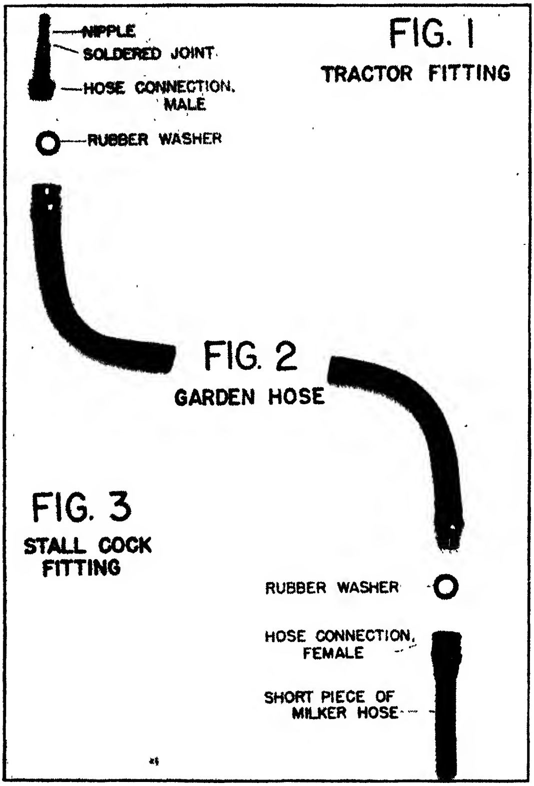
To use this method remove the intake manifold plug, install tractor fitting (Fig. 1), make garden hose (Fig. 2), and stall cock connection (Fig. 3). (Make sure all connections are tight.)

Close the stall cock and crimp the garden hose near the tractor before attempting to start.

A slow engine speed produces more vacuum than that of either one-half or full throttle. For successful milker operation set the throttle for the slowest R.P.M. at which the engine will operate satisfactorily.

Open stall cock slowly because a sudden demand for vacuum may stall the engine.

ARTICLE 31-15



Milking is accomplished in the usual manner, but as a precaution, check the vacuum gage and rate of pulsations.

When changing from milker pump to tractor for the source of vacuum, it is necessary to make the connection in such a way that the original vacuum tank will remain in the line. This tank serves as a supply tank to enable the tractor to maintain a constant, even amount of vacuum. A fluctuating vacuum gage reading and tendency for the tractor to stall result from the pulsator action, and uneven demands for vacuum if the supply tank is not used.

A relief valve is necessary because a tractor produces a vacuum of 18 to 22 inches of mercury. This is too high, as a milking machine requires only 10 to 16 inches of mercury, depending upon the make. A vacuum relief control is necessary in the line to maintain the re-

quired vacuum. Each milking machine installation has one of these controls in the line, so do not eliminate it when making the change.

The number of units operating successfully depends on the size of the smallest opening in the vacuum line. The authors have satisfactorily adapted a ⅛-inch pipe fitting to the intake manifold.

It was thought that adding a small amount of air through the intake manifold would have an effect upon the air-fuel ratio entering the engine. An exhaust gas analyser was used to test exhaust gases, and it was found that the tractor was operating within the normal range (Fig. 4).

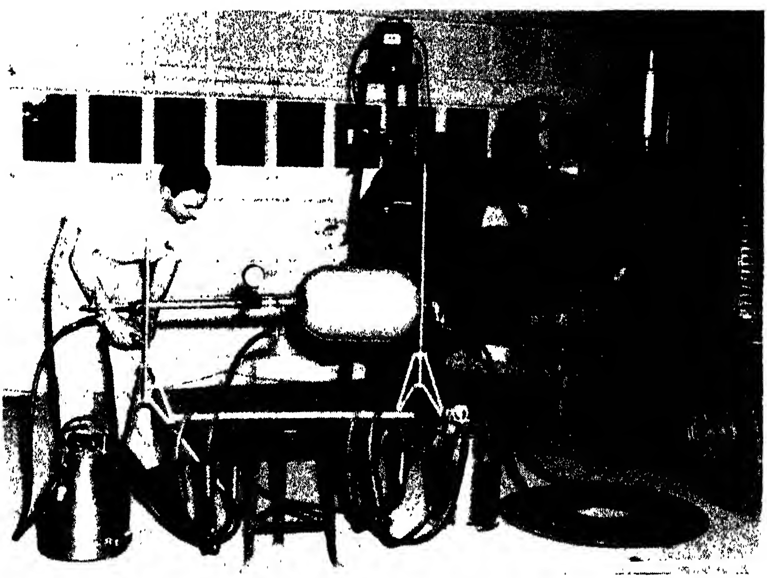


Fig. 4. Laboratory hook-up showing method of operation of milkers from farm tractor.

THE USE OF DUSTS AND CONCENTRATE SPRAYS TO PREVENT PRE-HARVEST DROP OF McINTOSH APPLES

By A. E. MITCHELL, WALTER TOENJES and C. L. HAMNER
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FRUIT GROWERS today are interested in the use of spray materials at strengths more concentrated than conventionally used. The following experiment was undertaken to determine the effectiveness of concentrated applications of naphthalene acetic acid applied in aerosol form to McIntosh apple trees, in comparison with conventional spray and dust applications for prevention of pre-harvest drop.

Twenty-seven mature, medium-sized McIntosh trees in one block and eight mature, medium-sized McIntosh trees in another block, located at the Graham Experiment Station of the Michigan State College, Grand Rapids, were selected for study.

The 27 trees were uniform in size and of the same bud strain, top-worked on Duchess interstock, growing in sod. The average yield per tree was 10 to 12 bushels. The block was divided into four groups of five or six trees for treatment. Four trees were left untreated as checks. The plan and the selection of trees were made in accordance with uniformity of crop and tree vigor.

The treatments were as follows: (a) Naphthalene acetic acid applied as a spray at 10 p.p.m., using a hand-operated gun and a conventional hydraulic sprayer[1] of 35 gallons per minute capacity operating at 500 pounds pressure; (b) naphthalene acetic acid applied as an aerosol at 37.5 p.p.m., using an Orchard Naconizer[2] and spraying from only one side of the machine; (c) naphthalene acetic acid ap-

[1]Manufactured by the Hardie Manufacturing Company of Hudson, Michigan.

[2]Manufactured by Naco Manufacturing Company of Huntington Park, California. This machine operates on the principle of an aerosol applicator. The air blast, created by a paddle-wheel type fan carries the spray material to the tree. The spray material is pumped into the air blast against the flow of air.

ARTICLE 31-16

plied as an aerosol at 100 p.p.m., using a Bean Mist Duster[3] equipped with a fishtail outlet in a fixed position; (d) commercially prepared sodium salt of naphthalene acetic acid dust applied as a dry dust, using a Niagara Cyclone Liqui-Duster.[4] The treated trees received approximately 0.5 gram of naphthalene acetic acid though not all trees were carrying 12 bushels of fruit. This procedure insured uniform application of material between groups

The second block of eight McIntosh trees, although growing in the same environment in sod, varied somewhat both in size and in bud strain of McIntosh. As this block was to contain check trees and one treatment of the sodium salt of naphthalene acetic acid at 1000 p.p.m. applied as a wet dust, the trees were paired, taking into consideration size and yield.

The strain differences of the trees were not realized until after the treatments were made. However, records of previous seasons failed to show any marked variation in percentage of dropped fruit between trees of different strains in this block. The estimated average yield per tree was 12 to 14 bushels, thus the treated trees received approximately 0.55 gram of the sodium salt of naphthalene acetic acid. This material was applied with a Niagara Cyclone Liqui-Duster.

The first hormone application was made for all treatments September 17, 1947, between 6:30 and 8:00 p. m.; as there was only a very slight breeze during this period. The trees were covered from two sides to insure uniform distribution of spray and dust material. The minimum air temperatures the following 24 hours were 62° F. and the maximum 83° F., which were relatively high for that season of the year. Warm weather continued 3 more days, then the temperature dropped below average for the season and remained low for 10 days. This cool period appeared to delay fruit drop and ripening. A second hormone application was made on all treatments September 25, 1947, between 6:30 and 8:00 p. m. when there was only a slight breeze. This second application was necessary because the fruit was immature and naphthalene acetic acid and the sodium salt of naphthalene acetic acid are commercially effective only 7 to 10 days. The air temperature at this time was 45° F. and dropped to 31° F. during the night.

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[3]Manufactured by the John Bean Manufacturing Company of Lansing, Michigan. This machine operates on the principle of an aerosol applicator. The air blast, created by a paddle-wheel type fan, blows the spray material to the tree. The spray material is pumped into the air blast at low pressure with the flow of air.

[4]Manufactured by the Niagara Sprayer and Chemical Company of Middleport, New York. This machine is a regular orchard duster to which has been added a sprayer unit that pumps liquid into air blast, wettting the dust particles as they leave the duster hose.

TABLE 1—*Effectiveness of dust and concentrate sprays of naphthalene acetic acid in preventing pre-harvest drop of McIntosh apples as compared with conventional sprays*

No.	Treatment*	Concentration	No. of trees	Average cumulative percentage drop at given dates							
				9/20	9/24	9/29	10/1	10/4	10/5	10/6	10/7
1......	Naphthalene acetic acid** applied as spray at 500 lb.......	10 p.p.m.	5	1.35	2.82	3.63	3.97	5.37	7.23	8.06	9.18
2......	Naphthalene acetic acid** applied as an aerosol...........	37.5 p.p.m.	6	1.33	3.22	3.92	4.22	5.07	7.04	7.81	9.50
3......	Naphthalene acetic acid** applied as an aerosol...........	100 p.p.m.	6	1.14	2.41	2.91	2.99	3.39	4.75	5.36	6.01
4......	Sodium salt of naphthalene acetic acid*** applied as a dust	1000 p.p.m.	5	2.16	5.10	6.42	7.35	10.38	15.51	16.99	22.42
5......	Check—no treatment	....	4	2.07	5.0	6.63	7.29	10.34	15.80	21.72	34.27

*Treatments applied September 17 and 25, 1947 between 6:30 p.m. and 8:00 p.m.
**Endrop, a commercial product of the Shell Oil Company, Inc. of New York, New York.
***A commercial product manufactured by the Niagara Sprayer and Chemical Company of Middleport, New York.

TABLE 2—*Effectiveness of wet dusts of sodium salt of naphthalene acetic acid in preventing pre-harvest drop of McIntosh apples*

No.	Treatment*	Concentration	No. of trees	Average cumulative percentage drop at given dates							
				9/20	9/24	9/29	10/1	10/4	10/5	10/6	10/7
1......	Sodium salt of naphthalene acetic acid** applied as a wet dust	1000 p.p.m.	4	0.17	1.65	2.12	2.34	3.13	5.08	7.25	10.90
2......	Check—no treatment	....	4	0.38	1.76	2.62	2.78	3.90	11.29	24.77	48.52

*First application made on September 17, 1947. Second application made September 25, 1947.
**A commercial product of the Niagara Sprayer and Chemical Company of Middleport, New York

The next day the air temperature did not go above 56° F. and this relatively cool, unseasonal weather continued 7 days, followed by seasonal temperatures.

The number of dropped fruits in the two blocks was recorded at 2- and 3-day intervals from September 18, 1947, until fruit drop became excessive and records were taken daily. The times of harvest, October 7 for Block I and October 8 for Block II, were based on the accepted standard of optimum maturity for McIntosh apples to be held in storage.

Records of average cumulated percentage of fruit drop at different time-intervals are shown in Tables 1 and 2.

The data in Table 1 show little or no differences 11 days following the first treatment, September 29, 1947, between the effectiveness of the conventional spray applications of naphthalene acetic acid at 10 p.p.m. and the concentrated spray application of 37.5 and 100. p.p.m. However, the dust treatment with 1000 p.p.m. of the sodium salt of naphthalene acetic acid when compared with no treatment on this date, seemed ineffective in reducing fruit drop.

At the time of harvest, October 7, 1947, 12 days following the second hormone treatment, the conventional application of 10 p.p.m. resulted in 23.09 percent reduction in average cumulative fruit drop as compared with the check, and as compared with 22.77 percent drop from the 37.5 p.p.m. concentration, and 28.26 percent from the 100 p.p.m. spray, and only 11.85 percent from the 1000 p.p.m. dust treatment. There was little or no difference between the average cumulative percentage fruit drop of the dust treatment and check until October 6, 1947, one day before harvest.

These results are contrary to the findings of Southwick (3), Hoffman, Van Doran and Edgerton (1), and Marth, Batjer and Moon (2). These investigators applied dust treatments early in the morning when the trees were wet with dew, while the dust treatments in this experiment were applied in the evening between 6:30 and 7:30 p. m. when the trees were dry. Windy conditions throughout the other periods of the 24 hours left no alternative in selecting the times of application.

A comparison of the average cumulative percentage fruit drop of the wet dust treatment and the check trees in Table 2 shows very little differences until October 6, 1947, 11 days after the second hormone application. However, one day later the average cumulative

percentage fruit drop of 24.8 for the check trees, was more than three times that of the wet dust treatment of 7.3 percent.

The fruit drop for all treatments shown in Table 1 was greater than the fruit drop of the wet dust treatment shown in Table 2 until October 7, 1947. Comparing the average cumulative percentage drop of the check trees in both tables from October 6, 1947, through October 8, 1947, one might assume that there was a delay of approximately 12 hours before the average cumulative percentage fruit drop on check trees, shown in Table 2, equalled that of the check trees, shown in Table 1. It is of interest to compare in the same way the results of the wet dust treatment in Table 2 on October 8, 1947, with the results from the treatments in Table 1 on October 7, 1947.

This comparison shows there was little or no difference between the effectiveness of the spray treatments and the wet dust treatment, but there was a decided difference between the effectiveness of the wet dust treatment and the dry dust treatment alone. This may suggest that the sodium salt of naphthalene acetic acid, to be effective in delaying pre-harvest drop of McIntosh apples, should be applied as a wet dust, or when the trees are wet.

A comparison of the effectiveness of the different methods and concentrations that may be used effectively in applying naphthalene acetic acid or its derivatives is of interest because aerosol spray and dust applicators are receiving considerable attention from entomological, pathological and horticultural research workers, and their usefulness to fruit growing appears of primary importance.

The concentrated applications of naphthalene acetic acid in concentrations of 37.5 p.p.m. and 100 p.p.m. applied as aerosols were as effective in preventing pre-harvest drop of McIntosh apples as was the conventional concentration of 10 p.p.m. applied with an hydraulic sprayer. Dry dusts were not so effective, but it is suggested that the effectiveness of the dust may be increased by applying it when the trees are wet, or by applying the dust as a wet dust.

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THE STABILITY OF CAROTENE IN ARTIFICIALLY-DRIED PLANT MATERIAL ON STORAGE

By B. C. RAY SARKAR[1]
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PREPARATION of a vitamin A-rich material in the form of a dried grass powder has been described recently by Sen, Ray and Ray Sarkar (4). Although the vitamin A activity of a fresh plant is maintained on artificial drying at 62-65° C., it is not known definitely how long the carotene is preserved in the dried material on subsequent storage. Taylor and Russell (7) showed that artificially-dried, chopped alfalfa hay, bagged and stored in a barn, lost one-half its carotene during the first three months of storage (late summer and early fall). There was no subsequent loss of carotene during the following winter but a further loss of one-quarter occurred during the succeeding summer, whereas no appreciable loss took place during the second winter of storage. The storage of artificially-dried and ball-milled alfalfa hay *in vacuo* in the dark at ±5° C. preserved the carotene efficiently for 20 months. The degree of fineness was of little importance.

Kon and Thompson (1) in England studied the influence of storage in the light and in the dark at ordinary temperatures, and in a heated room at 70-80° F., on the carotene content of finely ground, artificially-dried grass stored in paper sacks and in jute bags. The carotene content decreased 23.9 percent during the first month of storage, whereas the total loss was only 31.4 percent during the 6-month period (August to February). No differences were detected between treatments or types of containers. Seshan and Sen (6) pointed out that atmospheric oxygen plays the predominant part in the destruction of carotene and that heat, light and moisture act as accelerating agents.

To study the rates of decomposition of carotene in various artificially-dried forages under Indian conditions, the following experiment was undertaken.

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[1]Visiting Professor in Section of Agricultural Chemistry.

ARTICLE 31-17

EXPERIMENTAL PROCEDURE

The dried material was prepared in powdered form by the method of Sen *et al.* (4), from 4- to 5-week-old barley plants with three different moisture contents (Lot 1, 9.8; Lot 2, 3.6; and Lot 3, 14.5 percent, respectively). The percentage of dry matter and the carotene content per gram on the dry basis were: 90.2 and 333.3 ug. in Lot 1; 96.4 and 312.5 ug. in Lot 2; and 85.5 and 327.2 ug. in Lot 3, respectively. Two-gram portions of the powdered material from each lot were placed in Thunberg tubes, some of which were evacuated, others were filled with dry carbon dioxide, and the rest were left under atmospheric conditions. Some of the powdered product was also kept tightly packed in glass-stoppered bottles and in tin cans fitted with tight lids. Duplicate containers were then stored in a refrigerator (average temperature 10° C.) and at room temperature (average 31° C.) for various periods of time.

RESULTS AND DISCUSSION

Table 1 presents the data relating to the loss of carotene in the various samples in Lots 1 and 2 under different conditions of storage. It will be seen that after 13 months of storage, the carotene content

TABLE 1—*Stability of carotene in dehydrated barley plant powder under different storage conditions*

Sample No.	Storage conditions	Percentage variation with months of storage			
		1	4	7	13
	LOT 1 (9.8 percent moisture)				
1......	Low temperature + vacuum + dark............	0.0	− 4.9	6.1	11.1
2......	Low temperature + CO_2 + dark................	0.0	− 7.8	8.5	1.1
3......	Low temperature + atmosphere conditions + dark.	0.0	1.2	−10.7	−15.3
4*.....	Room temperature + atmosphere conditions + dark	0.0	−56.0	−56.0	....
5**....	Room temperature + atmosphere conditions + dark.	0.0	−35.3	−45.7	....
	LOT 2 (3.6 percent moisture)				
6......	Low temperature + vacuum + dark............	0.0	2.7	6.6	2.6
7......	Low temperature + CO_2 + dark................	0.0	− 8.7	− 6.3	6.9
8......	Low temperature + atmosphere conditions + dark.	0.0	− 9.9	− 7.1	−15.2

*Glass containers stored in cupboard in the laboratory.
**Tin can containers stored in cupboard in the laboratory.

did not decrease appreciably in six of the eight samples examined. In samples 4 and 5 the losses were 56 and 46 percent, respectively, after 7 months storage, so further analyses on these samples were discontinued in view of the heavy initial loss of carotene. Since the glass containers were kept in a cupboard without being wrapped in black paper (sample 4), some diffuse light might have had access to them, hence more carotene was destroyed than in those kept in the light-proof tins (sample 5). In samples 3 and 8 the destruction of carotene was approximately 15 percent in comparison with the lesser amounts destroyed in the samples preserved *in vacuo* or in carbon dioxide. Under similar conditions of packaging and storage at low temperature, dehydrating the powdered material to a greater degree did not maintain the original carotene content (Lot 2).

The apparent increase in the carotene content of samples 1, 2, 6 and 7 necessitated the re-determination of their carotene contents by combining the chemical method of Seshan and Sen (5) with the adsorption method of Moore (2) and then comparing these values with those obtained by the chemical method. The procedure has been described in a previous paper by Ray Sarkar and Sen (3). The results obtained are presented in Table 2. Under the foregoing experimental conditions some non-carotenoid pigments had developed. The amount of non-carotenoid pigments appears to be greater in Lot 1 which contained more moisture.

The above-mentioned results imply that in addition to temperature, light and air, the moisture content of dehydrated plant material plays an important role in the preservation of carotene. Under the conditions of the present investigation the most efficient preservation of carotene was obtained when the material was practically moisture-free, kept *in vacuo* or in an inert atmosphere, and stored in the dark at a low temperature. Even when the well-dried material was tightly packed and stored in light-proof containers under atmospheric conditions and at a low temperature, only 85 percent of the original carotene was preserved for more than one year (Table 1). The results of biological assays of samples from Lot 2, stored for eight months *in vacuo*, in the dark, and at a low temperature, demonstrated that the carotene, as estimated chemically, retained its full activity (Table 2). This would indicate that the carotene values obtained by the chemical method were indicative of the true potency up to seven months of storage.

TABLE 2—*True loss of carotene in dehydrated barley plant powder under different storage conditions*

Sample No.	Storage conditions of refrigerated samples	Carotene content determined by		Difference between (1) and (2)	True loss from original
		Chemical method (1)	Adsorption method (2)*		
		micrograms /gram		percent	percent
		LOT 1			
1......	Vacuum + dark................	370.3	296.4	20.0	11.1
2......	CO_2 + dark....................	329.6	240.0	27.2	28.0
3......	No vacuum + dark............	282.3	218.4	22.6	34.5
		LOT 2			
1......	Vacuum + dark................	320.6	294.8	8.0	5.7
2......	CO_2 + dark....................	334.2	302.4	9.5	3.2
3......	No vacuum + dark............	265.0	236.7	10.7	24.3

*A combination of the chemical and adsorption methods was used for these determinations (Ray Sarkar and Sen, 1946).

The effect of storage at room temperature under the above conditions was studied with some of the dehydrated material containing 14.5 percent moisture (Lot 3). The results obtained indicate that the material kept *in vacuo* in the dark retained less than 65 percent of the carotene after nine months of storage, whereas the losses varied from 70-98 percent under treatments such as no-vacuum plus light, no-vacuum plus dark and vacuum plus light.

SUMMARY

The stability of carotene in finely-ground barley plants has been studied under various conditions of storage.

Preservation of carotene became more effective when the material was dried to an almost moisture-free condition.

The best results were obtained when the dehydrated material was almost moisture free, kept *in vacuo* or in an inert atmosphere, and stored in the dark at a low temperature.

ACKNOWLEDGMENTS

The author is indebted to Dr. K. C. Sen for generously supplying all of the facilities required in the course of this investigation, and to Prof. C. W. Duncan, Section of Agricultural Chemistry, for helpful suggestions in the preparation of this manuscript.

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THE EFFECT OF BENZENE-HEXACHLORIDE ON SOME CROPS GROWN ON VARIOUS SOIL TYPES[1]

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SECTION OF SOIL SCIENCE

INVESTIGATIONS have shown that benzene-hexachloride is a promising insecticide for the control of wireworms, the larvae of Japanese beetles and other insects living in the soil. However, it is not too well established what influence applications of this insecticide to the soil may have on seed germination and growth of various vegetable and grain crops. The purpose of this study was to determine the effect of benzene-hexachloride applied at different rates on various crops when grown on soils of different texture and pH.

PROCEDURE

Four vegetable crops were used in this work, namely: Golden Cross hybrid sweet corn, Pencil Pod wax (snap) beans, Boston Pickling cucumbers and Early Scarlet Glode radishes. Seeds were planted in the summer of 1947 in 7-inch flower pots under a wire enclosure. Optimum moisture was maintained with the use of distilled water. All seeds were planted immediately after the application of the insecticide or within the following 3 days.

Five different soils were used, three of light texture and two of heavy texture (Table 1).

A 5-percent wettable benzene-hexachloride dust containing 10 to 12 percent of the gamma isomer was used. Applications were made at the rates of 800, 400, 200, and 100 pounds per acre, equivalent to 40, 20, 10 and 5 pounds, respectively, per acre of the technical grade

[1]Prepared from a thesis presented in partial fulfillment of the requirements for the M.S. degree in Soil Science at Michigan State College. The work was done under the joint direction of the departments of Soil Science and Entomology. Much credit is due Prof. E. I. McDaniel for supervision of the study.

ARTICLE 31-18

TABLE 1—*Properties of soils used and fertilizer application*

Soil series	Texture	Organic content	pH	Fertilizer used	Rate
		percent			lb./acre
Fox	Sandy loam	3.5	5.4	3-12-12	1000
Isabella	Sandy loam	2.1	5.9	3-12-12	1000
Wauseon	Sandy loam	5.4	7.5	3-12-12	1000
Miami	Clay loam	3.8	5.9	4-12-8	1000
Wisner	Clay loam	11.9	7.6	4-12-8	1000

of benzene-hexachloride. The insecticide and fertilizer were mixed and, in turn, the mixture was thoroughly incorporated with the top 3 inches of the soil.

Plants and soil were tested at various intervals for nutrient content by the Spurway quick test method. Appropriate amounts of nutrients were added whenever the tests indicated such applications were necessary.

DISCUSSION

Sweet Corn

Seed germination and the early growth of the sweet corn on light-textured soils appeared to be benefited by the use of this chemical. On the heavy-textured soils, germination was slightly retarded by this insecticide, and early stimulation of growth was not so noticeable as on the light-textured soils. This stimulation of early growth was more noticeable on the two sandy soils low in organic matter and less noticeable on the sandy loam high in organic material.

Stimulation persisted for approximately the first 17 days of growth. After this time, plants began to show symptoms of injury or toxicity. The tips of the lower leaves started to turn yellow, and in about 2 days, the entire lower leaf was brown and dry. This disorder continued in severity, and in 20 to 22 days after germination, it appeared as though the plants were going to die.

These signs of injury appeared in some respects, similar to those usually associated with potassium deficiencies of corn. However, tissue and soil tests revealed that a sufficient amount of plant nutrients were available for normal growth.

Symptoms of toxicity were especially severe on the sandy soils low in organic matter and considerably less severe on the sandy loam high in organic material. These symptoms were more acute at the two

heavier rates of application of the insecticide and not noticeable at the lowest rate. Generally speaking, symptoms of toxicity decreased as rates of application decreased. However, growth continued while plants were suffering injury but at a suppressed rate.

Toxicity symptoms were less noticeable on Miami clay loam than on sandy soils. Plants treated with 800 pounds per acre of the insecticide showed signs of injury but not sufficiently severe to impede growth. Pots treated with 400 pounds per acre of benzene-hexachloride showed slight signs of injury, while no depressing effect was observed from the 200-pound-per-acre treatment.

Sweet corn behaved differently on Wisner clay loam. On this particular soil, all rates of application had a depressing effect for approximately the first 35 days of growth but with no external symptoms of toxicity. After this period all plants resumed normal growth and at harvest time, plants from the treated pots were slightly larger than from the control pots.

Approximately 4 weeks after germination, indication of injury had decreased. Yellowing and browning of the leaves had subsided, color had improved and the entire plant assumed a more vigorous condition. Those plants not so severely affected made rapid recovery and growth, while plants on soil receiving the heaviest application, remained in a somewhat stunted condition.

Yields of dry plant tissue were variable, but for the most part, yields varied inversely with the rate of application. The least amount of plant tissue was produced on pots receiving 800 pounds per acre of benzene-hexachloride. Yields from the remaining three rates of application were erratic, but a greater quantity of dry plant tissue was produced than from the untreated soils.

Wax Beans

Germination of wax beans was not affected in any way on the light-textured soils by applications of the insecticide, but on the heavy soils germination was improved.

The beans showed no external symptoms of toxicity as did the sweet corn. On Fox sandy loam, plants on the treated soils appeared to be normal throughout the growing season. However, on Isabella sandy loam, growth seemed slightly depressed by all treatments after the first 20 days of growth but showed no external signs of disorder. Plant growth on Miami clay loam receiving the 200-pound-per-acre

application was superior, while growth was definitely stimulated by all rates of application on the Wisner clay loam. No particular rate of application appeared most beneficial.

No difference in blossoming time was observed between plants on treated and untreated pots of the soils of different texture. The number of blossoms produced and the length of time the flowers were open were equal for treated and untreated soils.

The weight of bean pods produced by plants grown on the treated heavy soils was greater than that from plants on the untreated soils. This result is not in conformity with the yields obtained from the sandy soils, as in this case plants on untreated soil produced the greatest amount of bean pods.

Much concern has been expressed regarding possibilities of an off-taste in crops grown on soil treated with benzene-hexachloride. Samples of beans were scored for taste by members of the Foods and Nutrition Department. Results indicated that this particular variety of wax beans did not assimilate benzene-hexachloride in sufficient quantities to impair its edible qualities.

Cucumbers

Germination of the cucumber seed was not affected on either the light- or heavy-textured soils by application of varying amounts of benzene-hexachloride.

No symptoms of toxicity were observed on the plants grown on the treated light-textured soils. In fact, growth and color were improved. However, stimulation was not consistent between treatments. On the Fox sandy loam, the 200-pound-per-acre treatment produced the greatest growth. On the Isabella sandy loam, the degree of stimulation was inversely proportional to the rate of application. The degree of stimulation was equal for all treatments on the Wauseon sandy loam, and growth on all treated soil was superior to that on the untreated soil. On the other hand, growth of cucumbers on the heavy soils appeared to be slightly retarded by heavy applications of benzene-hexachloride. To generalize, on the light- and heavy-textured soils the use of this insecticide at the lower concentrations improved growth and color of the plants.

Neither application of the insecticide nor soil texture influenced the blossoming of the plants.

The amount of dry plant tissue produced on the light-textured treated soils was greater than on the untreated soil, but there was no appreciable difference in the weight of plant tissue produced on the treated and untreated soils of heavy texture.

Radishes

Radishes grew very poorly, owing to the unfavorable growing condition for this crop. Therefore, the following conclusions must be regarded as indications only.

Germination of radish seed on the treated sandy soils was somewhat benefited by the use of this chemical, while on the heavy-textured soils, no such indications were apparent.

Growth of radishes on the light-textured soils was slightly stimulated by the use of this chemical from all rates of application. From the start of growth, plants on the treated soils were superior to those on untreated soils and remained so throughout the growing season. Similar results were obtained on the treated heavy-textured soils. The data also show that root growth was greater on the treated soils than on the untreated soils regardless of the texture.

Radishes when grown on sandy soils treated with more than 100 pounds per acre of benzene-hexachloride had a characteristic off-taste. However, radishes grown on the heavy-textured soils gave no indications of such a taste, regardless of rate of application.

CONCLUSION

One hundred pounds of benzene-hexachloride applied by the method used in this experiment to light-textured soils will cause no harmful effects to the hybrid variety of Golden Cross sweet corn. Applications above this concentration may cause symptoms of toxicity, with 800 pounds per acre being definitely toxic. Corn growing on sandy soils high in organic matter may be able to withstand heavier rates of application without showing symptoms of toxicity.

On heavy-textured soils, 200-pounds-per-acre applications of benzene-hexachloride will cause no harmful affects to this particular variety of sweet corn. Applications of 400 pounds per acre may cause damage.

The maximum amount of benzene-hexachloride used in these trials can be applied to the soil with no deleterious effects to Pencil Pod wax beans.

Boston Pickling variety of cucumbers grown on sandy soils low in organic matter may be injured with a 400-pound-per-acre application of benzene-hexachloride. Treatments should be kept at or below this maximum limit. Larger amounts of the insecticide may be applied to sandy soils high in organic matter. On heavy-textured soils, applications of 400 pounds per acre may be safely made with no harmful effects to the plants.

Early Scarlet Globe radishes should not be grown on light-textured soils that are treated with more than 100 pounds per acre of benzene-hexachloride. Applications exceeding this rate will give radishes a characteristic off-taste and smell. On heavy-textured soils, benzene-hexachloride may be applied at the rate of 800 pounds per acre without causing harmful effects on the plants or producing an off-taste or smell in the radishes.

RESIDUAL EFFECTS

The above-mentioned vegetable crops were harvested in the last week of August and the pots were taken into the greenhouse to determine if this insecticide has any residual effects on the subsequent crops that may be grown in the rotation. Approximately 7 weeks after the summer crops were harvested, four cover crops were planted.

Germination of Eaton oats, Bay barley, Rosen rye and Yorkwin wheat was not affected in any way by the use of this insecticide in the soil.

This investigation showed that there is a residual effect of benzene-hexachloride on following crops in the rotation. The heavier rates of application caused stimulation and the lower rates appeared to be deleterious in some cases. Oats showed the greatest stimulation being followed very closely by barley. Rye showed the least effect.

STIMULATION

It has been observed throughout this work that a definite improvement in growth, vigor and color was noted in each crop in varying degrees when the soil was treated with benzene-hexachloride. The degree of stimulation varied with the crops and the soils used.

A similar condition was reported by Lange (3). This worker offered the hypothesis that the physical or chemical properties of the soil might be changed or that an increase in population of the more

beneficial bacteria accounted for these benefits. It seems doubtful that a sufficient change in physical soil properties would occur to account for the results. However, it is thought that the chemical properties may be altered and that the bacteria population of the soil could be advantageously changed.

Workers in Scotland (2) reported that when turnips were planted with a mixture of benzene-hexachloride and fertilizer, growth was more vigorous and color was improved. Similar results were observed on oats. It was concluded that the insecticide exerted this stimulation by reducing the number of harmful bacteria in the soil.

Annand (1) reports that this insecticide may act as a hormone on some varieties of plants.

It is suggested by the writer that stimulation is probably caused by the chemical breakdown of this compound in the soil. In the presence of a weak alkali, such as the soil calcium, this compound breaks down to form the isomers of trichlorobenzene. Perhaps it is this chemical (4), together with a greater population of beneficial bacteria in the soil, that exerts the stimulating effect.

It is thought that the degree of stimulation of growth is attributed to the texture of the soil rather than the pH value. Increases in growth and improvement in color are not as marked on the heavy-textured soils (clay) as on the lighter-textured soils (sand). It appears that stimulation is inversely proportional to the amount of colloidal material in the soil. This colloidal material may be either the organic or inorganic colloidal fraction of the soil. Therefore, it is concluded that the organic or inorganic colloids act as a buffering agent and the greater the amount of colloidal material in the soil, the less the stimulation exerted by the insecticide.

It is important to keep in mind that results contained herein should be regarded as indications only and not as conclusive data. More research is necessary before definite and accurate conclusions can be drawn.

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AN AUTOMATIC SELF-CLEANING WATER BOWL FOR HOGS

By W. N. McMILLEN, W. H. SHELDON *and* W. G. PEART[1]
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ADEQUATE QUANTITIES of clean, fresh water for livestock are just as essential as feed for economical production. In fact, animals suffer quicker from a lack of sufficient water than from underfeeding. The only satisfactory way to provide a constant supply of fresh water is through the use of some type of automatic waterer attached to a pipe line from the water pump.

Fig. 1. The automatic self-cleaning water bowl saves labor and furnishes clean water for hogs.

[1]The authors are grateful to Fred Rinker, technician in Animal Husbandry, for suggestions and help in developing the waterer.

ARTICLE 31-19

Automatic water bowls for dairy cows and watering devices for hogs have been in use for many years. These devices have the disadvantage of being difficult to keep clean and of flooding the pen or lot.

AUTOMATIC SELF-CLEANING WATER BOWL

The automatic self-cleaning water bowl shown in Figs. 1 and 2 has been in use for hogs at Michigan State College since August 1948. It has furnished a constant supply of clean fresh water with a minimum of attention.

The experimental unit illustrated in Figs. 1, 2 and 3 is a standard automatic dairy water bowl with a built-in siphon trap and drain similar to that used in a flush toilet. This water bowl has the usual valve mechanism which is operated by the animal as he drinks.

Whenever a hog holds the valve control down until the bowl fills to within about 2 inches of the top, water runs out the overflow and through the drain, away from the lot or pen. Excess water siphoning out from the bottom of the bowl flushes away dirt which may have accumulated.

The flushing can be accomplished by any of the following methods:

1. By manual operation of the regular supply valve control; sometimes hogs when drinking hold the valve control down long enough to cause flushing.

2. By means of a hand valve in the pipe line that leads to the flushing jet.

3. By an automatic dumping mechanism as shown in Figs. 2

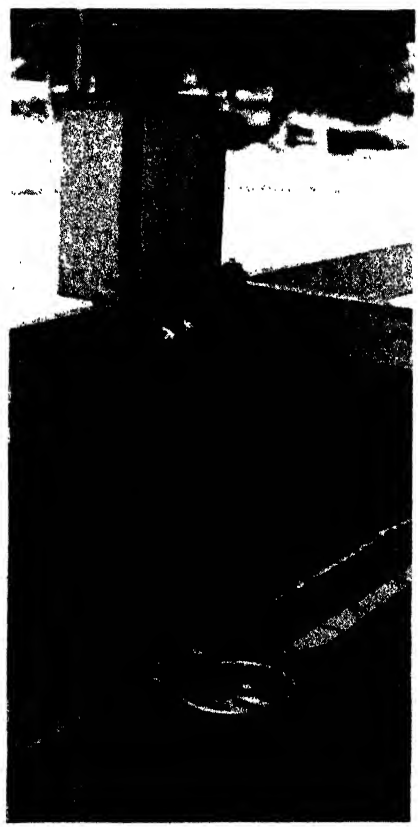

Fig. 2. Experimental water bowl with automatic self-flushing device.

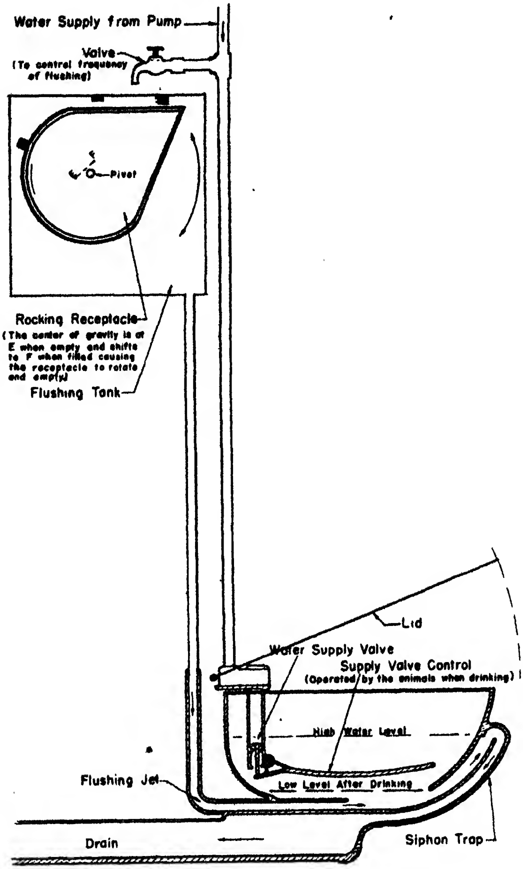

Fig. 3.

and 3. This is a small sheet metal flushing tank enclosing a rocking receptacle mounted on a pivot. A small trickle of water fills the rocking receptacle which, when filled with a gallon of water, empties into the flushing tank.

ADVANTAGES

The following desirable features have been noted:

1. Furnishes a constant supply of clean fresh water.

2. Reduces manual cleaning to a minimum.

3. Eliminates water hauling.

4. Prevents mudholes or flooding of the pen.

5. Preliminary data indicate that pigs drink more water and make faster gains.

6. Rings in the noses of the pigs do not interfere with the operation of the valve control mechanism.

7. On hot days the water is cool.

8. Should aid in prevention of water-borne diseases.

9. Easily adapted to any size hog.

FURTHER POSSIBILITIES

The features of this automatic water bowl and flushing mechanism are desirable for all classes of livestock. Further studies are being made on its use and possibilities for swine, cattle, sheep and horses. These studies include: 1) water consumption, 2) time and labor saved, 3) rate of gain and economy of production, and 4) bacteriological studies.

FARM BUSINESS REPORT FOR 1947

By N. L. SMITH, E. M. ELWOOD, E. H. CARTER, and J. C. DONETH[1]
SECTION OF FARM MANAGEMENT

RAPIDLY INCREASING COSTS and, in some sections of the state, adverse weather, especially for spring-sown crops, offset to a considerable extent the effect of favorable 1947 prices for farm products. In general, properly managed farms returned more dollars above expenses in 1947 than ever before. On some farms lack of proper management resulted in less than maximum production, failure to take advantage of the best markets, or in expenses that were higher than justified on the

PRICES AND COSTS

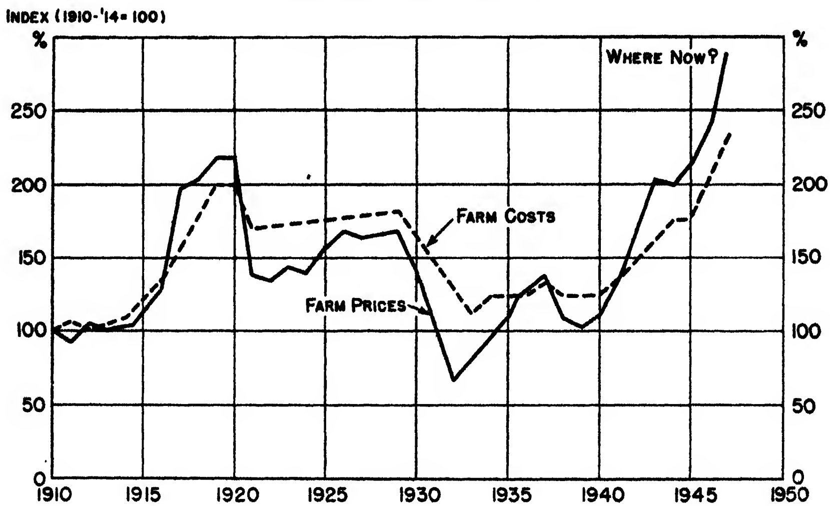

Fig. 1. Michigan farm prices and costs 1910-47.

[1]The Farm Management Department of Michigan State College together with the county agricultural agents and the Michigan Agricultural Experiment Station again sponsored the extension project in farm accounting. This project has been continuous since 1929. Reports were prepared for each type-of-farming area except 13, based on farm accounts kept in each area.

Area	Name
1.	Corn and Livestock
2.	Small Grains and Livestock
3.	Southwestern Fruit and Truck Crops
4.	Poultry, Dairy and Truck Crops
5.	Dairy and General Farming
6.	Dairy and Cash Crops
7.	Dairy, Hay, and Special Crops
8.	Beans, Sugar Beets, and Dairy
9.	Cattle, Sheep, and Forage
10.	Central Potato and Dairy
11.	Northern Fruit and Dairy
12.	Northern Potato and Dairy
13.	General, Self-Sufficing, and Part-Time
14.	Cattle, Potatoes, and Self-Sufficing
15.	Cattle, Hay, and Spring Grains
16.	Dairy and Potatoes
17.	Potatoes, Dairy, and Part-Time

Fig. 2. Types of farming in Michigan.

basis of volume of business. As a result, incomes on some of these farms were less than could be reasonably expected from the resources available.

Both farm product prices and costs reached a record high in 1947. Prices received by farmers for products sold increased from 242 percent of the 1910-14 average in 1946 to 294 percent in 1947. With the exception of fruit and wool price increases were general. Results of the increase is reflected in incomes shown by the 830 Michigan farms included in this report.

Costs increased 17 percent over 1946 as contrasted with the 21-percent increase in prices received. The price-cost ratio, at 129

percent, continued to favor the producer. This relationship has not always been favorable to farmers (Fig. 1). It seems unlikely that farm product prices will continue at their 1947 level or higher, other than for a short time. When the margin between prices and costs will decrease, and thus become less favorable to farmers, cannot be accurately forecast. However, any adjustments which can be made to decrease farm operating costs without decreasing the efficiency or volume of the farm business are advisable.

FARM EARNINGS

The increase in prices received offset increased costs and adverse weather conditions which reduced production on many farms. As a result, farm earnings for the 830 farms included in this report were slightly higher than in 1946 and the highest on record. Labor incomes (gross receipts minus interest on investment and all expenses except a charge for operator's labor) averaged $3,486 per farm. This was $112 above the 1946 average of $3,374. It is significant, however, that labor incomes on farms cooperating in the accounting project have averaged less than $1,000 in 11 out of the past 19 years and that in three of the past 19 years incomes were insufficient to pay operating expenses and interest on the investment. The earning power of a farm over a period of years is more important than the earnings for any one single year.

Both expenses and receipts continued at a level of about three times their 1935-39 average. The average expense per farm in 1947 amounted to about 75 percent more than the average gross income per farm in 1935-39.

TABLE 1—*Farm earnings on farm accounting farms in Michigan, by years, 1929-47*

Year	Labor income	Year	Labor income
1929	$ 585	1939	$ 780
1930	−263	1940	787
1931	−676	1941	1,675
1932	−595	1942	2,303
1933	249	1943	1,990
1934	565	1944	2,406
1935	764	1945	2,483
1936	1,318	1946	3,374
1937	569	1947	3,486
1938	571		
19-year average			$ 1,177

TABLE 2—*Comparison of gross income, expenses and labor incomes on farm accounting farms in Michigan, 1935-39 average, and by years 1943-47*

Item	1935-39	1943	1944	1945	1946	1947
INCOME						
Crops and AAA payments	$ 881	$ 1,684	$ 2,215	$ 1,948	$ 2,641	$ 2,663
Dairy products	910	2,054	2,562	2,782	3,366	3,456
Cattle	338	624	576	727	894	1,082
Hogs	224	686	622	538	748	949
Poultry and eggs	256	633	586	744	711	805
Sheep	112	122	102	102	137	126
Other	161	214	212	214	221	351
	$ 2,882	$ 6,017	$ 6,875	$ 7,055	$ 8,718	$ 9,432
EXPENSES						
Feed bought	261	910	870	889	921	1,231
Machinery	291	606	717	793	922	1,162
Hired labor	231	490	635	557	767	634
Crop expense	193	397	498	544	741	770
Family labor	197	390	399	386	418	468
Improvements	138	213	244	247	317	349
Taxes	74	86	96	103	118	128
Other	56	137	165	177	209	216
Total expense	$ 1,441	$ 3,229	$ 3,624	$ 3,696	$ 4,413	$ 4,958
Net farm income	1,441	2,788	3,251	3,359	4,305	4,474
Interest on investment at 5%	641	798	845	876	931	988
LABOR INCOME	$ 800	$ 1,990	$ 2,406	$ 2,483	$ 3,374	$ 3,486

FARM INVESTMENTS

Higher costs mean larger investments in the farm business. This is substantiated by the $2,369 increases over 1946 in the average investment per farm on the farms studied. The increase was distributed between real estate and personal property, $992 and $1,377, respectively. These investments do not represent the current selling price. The investment in real estate represents more nearly the actual purchase price of the farm at the time it was bought or its long-time

TABLE 3—*Investments per farm on 830 Michigan farms, 1947*

Item	Investment per farm	Percent of total
REAL ESTATE		
Land	$ 6,527	31
Improvements (less house)	5,183	25
Orchard	338	2
PERSONAL PROPERTY		
Livestock (includes horses)	3,220	15
Machinery and equipment	3,315	16
Feed, crops, and supplies	2,414	11
Total	$ 20,997	100

productive value. Feed and livestock investments more nearly represent current prices. Machinery investment represents the undepreciated balance of the cost of the machine.

VARIATION IN INDIVIDUAL FARM INCOME

Some reasons for variation in farm incomes are easily listed. Most of the faulty management practices could be rather easily corrected if recognized and corrective action taken. They are:

1. Variation in amount of acreage, especially tillable acres.

2. Insufficient amount of livestock; a type of livestock not suited to the farm; or low-producing livestock.

3. Failure to grow crops adapted to the farm; production of low-value feed or cash crops; or low yields.

4. Failure to take advantage of the best market available; or failure to market produce in top condition.

5. Failure to keep expenses in line with the volume of business.

6. Failure to maintain or improve soil fertility.

TABLE 4—*Percentage distribution of labor incomes, by years 1929-47, Michigan*

Year	Total number of farms	Farms in each labor income group		
		$0 or less	$1 to $1,000	$1,001 or more
		Percent	Percent	Percent
1947	830	5	11	84
1946	838	4	9	87
1945	939	6	17	77
1944	1,031	5	18	77
1943	1,097	8	24	68
1942	1,160	2	18	80
1941	1,041	5	27	68
1940	1,263	12	55	33
1939	1,346	14	54	32
1938	1,252	20	57	23
1937	1,163	22	54	24
1936	1,055	6	43	51
1935	933	13	56	31
1934	845	21	56	23
1933	705	35	55	10
1932	831	87	12	1
1931	925	83	16	1
1930	771	62	32	6
1929	427	23	52	25
19-year average	976	23	35	42

A more detailed discussion of these variations appears in the Farm Business Report for the particular type-of-farming area concerned. Evidence that farms change from one income group to another is indicated in Table 4. Changes in the general price level have been important in bringing about these shifts in income but the influence of management is also very important.

SIZE OF BUSINESS

On the average, the farms studied changed very little in size and intensity of operations. Lack of labor discouraged some farmers from expanding and caused others to decrease the size of their operation. Volume of business has been maintained on many farms despite the labor problem by increasing the amount and use of machinery. Many farmers are satisfied with their income and have no desire to increase operations at this time. On many farms there is sufficient labor and/or machinery to enable an increase in size of business with very little increase in operating expenses. On such farms such an increase could mean improved efficiency.

TABLE 5—*Comparison of size of farm, amount of livestock and amount of work 1935-39 average and 1943-47 by years, Michigan*

Item	1935-39	1943	1944	1945	1946	1947
Number of farms	1,150	1,097	1,031	939	838	830
Total acres	162	185	193	195	195	193
Tillable acres	107	122	129	131	133	134
Productive animal units	20.8	27 6	27.9	26.5	27.8	27.1
Productive man work units	432	480	506	490	491	454
Number of men	1.9	1.8	1.9	1.7	1.8	1.7
Work units per man	227	269	286	271	266	267

CROPS

Adverse weather and the consequent curtailment of production accompanied by lower fruit prices were sufficient to offset the general increase in crop prices. As a result, crop incomes averaged $2,663 in 1947, compared with $2,641 in 1946, an insignificant change. The late, wet, spring weather was the major factor in reducing crop production.

Although some use of commercial fertilizer is made on most farms, most farms do not reach the maximum possibility in its use. In terms

of most farm produce, fertilizer was a considerably "better buy" in 1947 than before the war and is likely to continue so for the next year at least.

LIVESTOCK

Most of the increase in income came from livestock and livestock products. This again, result of price increases rather than increases in production. The high cost of purchased feed and scarcity of home-grown feed grain resulted in less grain being fed with consequent lower production.

Livestock and livestock products accounted for 68 percent of the gross income. Dairying was the most important single source of income, with the sale of dairy products, alone making up 37 percent of the gross income and 54 percent of the income from livestock products. Crops accounted for 28 percent, cattle 11, hogs 10, poultry and eggs 9, sheep 1, and other income 4 percent of the gross.

The variation in dairy product sales per cow ranged from a low of $21 to a high of $504 on the farms studied. Better breeding, as well as better feeding and herd management, is more important than many dairymen seem to comprehend. Artificial insemination seems to offer a possibility of definite improvement in production on a majority of dairy herds.

Livestock-feed ratios were such during part of the year that only the more successful livestock enterprises were able to more than pay feed costs. This situation was especially critical during the spring and early summer months.

FARM EXPENSES

Average expenses per farm on the farms included in the study increased from $4,413 in 1946 to $4,958 in 1947. This was largely due to the increase in prices of purchased items. Although the increase was general and included all items of expense, the largest increase was in purchased feed. This was brought about by the reduction in home-grown feeds and the high prices of feed grains.

Labor continued to hold its place as the largest single item of farm expense even though the farm operator's labor was charged at hired wage rates. Improvement in labor efficiency offers one of the greatest possibilities of decreasing expenses on many farms. Often this can be

accomplished by use of relatively inexpensive labor-saving devices and by some careful planning of farm tasks.

Purchased feed was the second largest farm expense, machinery expense was a close third. A certain amount of the right kind of machinery is a necessity for efficient operation, but some farms, are overloaded. These usually have a small tillable acreage. Such overloading results in increased overhead costs that in less favorable price periods are not justified by the farm volume.

Expenses on farm improvements, although not usually as large an expense as labor, machinery and equipment, and purchased feed, are often excessive. This usually arises out of over-building and the consequent excessive expense due to depreciation, repair and maintenance. Buildings not fully utilized mean needless costs.

STATE AND AREA AVERAGES

Farm earnings vary annually depending on prices, costs, weather, etc., and the effect of these factors upon farm income. A comparison of investments, income, expenses, crop and livestock enterprises by type-of-farming areas appears in tables 6, 7, 8, and 9.

(Tables 6, 7, 8 and 9 appear on pages 190-193.)

TABLE 6—*Financial summary of 830 Michigan farms by type-of-farming areas, 1947*

Type-of-farming areas	All farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	830	95	78	17	45	149	34	26	83	29	75	24	48	22	27	22	56
Total acres	193	196	224	116	156	215	198	213	166	203	185	146	228	224	205	187	153
Percent of farm acres tillable	69	77	79	79	77	75	78	79	76	59	63	67	57	44	64	45	41
Tillable acres	134	151	177	92	120	162	154	168	126	119	117	98	130	99	132	85	63
Real estate (less house)	$12,048	$13,638	$12,889	$16,385	$11,107	$13,640	$14,969	$13,849	$13,850	$ 8,837	$ 8,608	$13,846	$ 6,594	$ 6,609	$ 5,892	$ 7,592	$ 4,697
Machinery and equipment	3,315	3,419	3,353	3,544	3,497	3,456	3,633	3,554	3,432	2,707	2,959	4,108	2,756	1,987	2,288	2,629	2,059
Livestock (includes horses)	3,220	3,958	3,460	1,427	2,886	3,984	3,559	3,983	2,790	4,055	2,344	1,225	1,845	1,770	1,904	2,307	1,724
Feed and crops	2,414	3,409	2,573	1,702	2,196	2,774	2,616	2,414	2,644	1,447	1,503	3,098	1,417	1,260	1,174	1,209	731
Capital investment, total	20,997	24,424	22,275	23,058	19,686	23,854	24,777	23,800	22,716	17,046	15,414	22,275	12,612	11,626	11,258	13,737	9,211
Livestock income	6,418	8,211	7,886	2,875	8,666	8,010	7,765	6,916	6,249	5,537	5,311	2,794	3,784	3,883	3,552	6,108	3,810
Crop income	2,663	2,813	3,372	6,824	1,830	3,077	3,061	1,992	4,111	941	1,443	8,060	1,444	1,361	1,518	967	644
Other income	351	392	284	339	404	366	429	384	253	417	342	358	245	219	409	368	499
Gross income	9,432	11,416	11,542	10,038	10,900	11,453	11,255	9,292	10,613	6,895	7,096	11,212	5,473	5,463	5,479	7,443	4,953
Total expenses*	4,958	5,599	6,128	7,581	6,163	5,550	6,224	5,382	4,976	3,733	3,941	7,543	3,225	2,787	2,560	3,706	2,825
Net farm income	4,474	5,817	5,414	2,457	4,737	5,903	5,031	3,910	5,637	3,162	3,155	3,669	2,248	2,676	2,919	3,737	2,128
Less: interest at 5%	988	1,221	1,114	1,153	984	1,193	1,238	1,190	1,136	852	764	1,114	631	582	564	687	460
Labor income 1947	3,486	4,596	4,300	1,304	3,753	4,710	3,793	2,720	4,501	2,310	2,391	2,555	1,617	2,094	2,355	3,050	1,668
Labor income 1946	3,374	4,337	3,169	4,378	3,011	3,312	2,988	3,585	4,413	2,489	2,485	7,635	2,221	2,066	2,267	2,954	2,357
Labor income 1945	2,483	3,432	2,464	1,434	2,710	3,228	2,807	2,181	2,978	1,514	2,226	2,667	1,554	1,613	1,345	1,766	1,653
Labor income 1944	2,406	2,719	1,452	3,536	2,409	2,496	2,712	2,753	2,940	1,815	2,393	5,831	1,819	1,613	1,661	1,850	1,551
Labor income 1943	1,990	2,235	2,473	4,475	2,101	2,222	2,378	1,502	2,272	929	1,704	3,590	1,380	1,098	670	1,683	1,080
Labor income 1942	2,303	3,056	2,389	2,637	2,142	2,763	2,856	2,673	2,543	1,636	2,330	2,806	1,489	1,253	1,346	1,601	1,193

*Includes family labor but not operator's labor or interest on investment.

TABLE 7—*Kinds of crops and percentage of tillable land in different crops and also yields by type-of-farming areas in Michigan, 1947*

Type-of-farming areas	All farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	830	95	78	17	45	149	34	26	83	29	75	24	48	22	27	22	56
Number of tillable acres	134	151	177	92	120	162	154	168	115	119	117	98	130	99	132	85	63
Percent in sod crops	44	34	40	28	39	39	52	55	33	54	51	33	54	59	60	60	67
Percent in legumes	30	22	28	18	20	26	35	36	25	33	24	21	27	38	26	44	33
Percent tillable acres in:																	
Tillable pasture	17	14	17	9	15	16	22	24	13	23	19	12	21	23	15	13	13
Alfalfa hay	11	10	11	14	8	12	16	12	11	10	13	7	12	18	2	16	5
Other hay	16	10	12	5	16	11	14	19	9	21	19	14	21	18	43	31	49
Corn (includes corn silage)	17	26	23	14	21	21	15	11	16	16	14	10	11	3	—	10	—
Wheat	12	16	17	3	15	16	9	10	13	8	7	5	5	9	5	2	1
Oats and oat mixtures	10	11	12	8	17	11	9	3	11	10	11	6	11	7	14	17	18
Barley	2	—	—	—	1	1	1	1	3	1	—	—	1	5	2	3	2
Beans	3	—	—	—	—	2	3	6	15	3	2	—	—	—	—	—	—
Sugar beets	1	—	—	—	—	1	1	3	3	1	—	—	—	—	—	—	—
Potatoes	1	—	—	—	—	—	1	—	—	—	3	1	6	3	—	3	3
Fruit and truck	2	—	—	40	2	—	3	—	—	—	—	36	—	—	—	—	—
Other crops	5	9	6	5	4	7	3	9	5	7	10	5	7	11	15	4	4
Idle	3	4	2	2	1	2	3	2	1	—	2	4	5	3	4	1	5
Crop yields per acre:																	
Alfalfa hay	1.8	2 0	1.6	2.4	2.1	1.9	2.0	2.0	2 0	1.5	1.6	1.9	1.4	1.7	2 4	1.9	1.8
Other hay	1.4	1.6	1 2	1 8	1.5	1 4	1 5	1.4	1 4	1.4	1 4	1 1	1 1	1.1	1.4	1.7	1.7
Corn silage	6.0	—	—	5.3	5 6	—	—	6.3	—	—	—	6.2	4.7	—	—	9.9	—
Corn (shelled)	30	30	25	27	27	31	36	33	39	26	28	23	22	25	—	—	—
Wheat	27	27	26	38	30	27	26	20	31	22	27	31	21	23	20	24	17
Oats	37	35	36	43	43	41	36	35	46	33	33	—	27	34	22	52	33
Barley	21	—	—	—	35	27	26	14	31	4	—	—	23	23	35	34	18
Beans	10	—	—	—	—	9	9	7	12	9	6	—	—	—	—	—	—
Sugar beets	6 4	—	—	—	—	4.9	7.3	4.1	7 2	4.8	—	—	—	—	—	—	—
Potatoes	139	—	—	—	—	—	166	—	—	—	151	125	109	225	—	239	198
Crop yield index	100	101	90	115	106	103	108	93	116	89	93	89	77	89	89	127	116
Crop sales and AAA payments	$ 2,132	$ 2,250	$ 2,355	$ 6,598	$ 1,121	$ 1,935	$ 2,419	$ 1,757	$ 3,450	$ 901	$ 1,231	$ 9,167	$ 1,211	$ 1,026	$ 1,327	$ 789	$ 611
Crop income, total	2,663	2,813	3,372	6,824	1,830	3,077	3,051	1,992	4,111	941	1,443	8,060	1,444	1,361	1,518	967	644
Feed bought	1,231	1,474	1,900	1,047	2,315	1,498	968	1,418	1,027	778	1,029	738	544	512	542	950	765

TABLE 8—*Livestock: Kinds, amounts, and returns from livestock by type-of-farming areas in Michigan, 1947*

Type-of-farming areas	All farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	830	95	78	17	45	149	34	26	83	29	75	24	48	22	27	22	56
Livestock income, total	$ 6,418	$ 8,211	$ 7,886	$ 2,875	$ 8,666	$ 8,010	$ 7,765	$ 6,916	$ 6,249	$ 5,537	$ 5,311	$ 2,794	$ 3,784	$ 3,883	$ 3,552	$ 6,108	$ 3,810
Livestock income per T.A.*	47 88	54 41	44 65	52.05	71.93	49 57	50 41	41.08	49 50	46.59	45.29	44.69	29 12	39.10	26.97	71.86	60.11
Productive animal units	27.1	36.1	35.7	10.4	26.3	33.1	28 5	30.7	24 5	27.6	22.7	11.2	20 2	21.1	16.3	24.4	17.4
Tillable acres per PAU**	5 0	4.2	4 9	5 3	4.6	4.9	5 4	5.5	5 2	4 3	5.2	5 6	6.4	4.7	8.1	3.5	3.6
Cattle:																	
Percent of farms reporting	99	97	96	100	100	99	100	100	100	100	99	88	100	100	100	100	98
Cows per farm reporting	12 5	11.6	13 5	5 3	13 8	13.5	16 7	15.6	11 9	12.3	11 7	6 4	11.0	9.5	9.6	17.3	12.6
Dairy sales per cow	$ 282	$ 303	$ 287	$ 291	$ 324	$ 315	$ 321	$ 305	$ 294	$ 191	$ 253	$ 248	$ 199	$ 190	$ 207	$ 286	$ 244
Dairy sales at farm reporting	3,507	3,504	3,856	1,536	4,478	4,299	5,349	4,756	3.507	2,362	2,951	1,598	2.187	1,803	1,986	4,963	3,074
Cattle income at farm reporting	1,098	1,359	1,015	608	1,102	1,234	1,433	1,816	1.095	1,864	999	541	794	1,294	645	814	486
Hogs:																	
Percent of farms reporting	66	86	76	35	51	73	38	31	70	79	60	50	85	91	63	45	41
Sows per farm reporting	2.1	3 5	4.1	.5	1.1	2.7	1.4	.8	1 5	1.7	1.4	.7	1 1	.7	.5	.1	.4
Litters farrowed per farm	3.6	6.6	7.1	1 0	1 7	4.8	2 3	1 1	2.6	2.1	2.6	1.1	1.5	1.0	.6	.1	.6
Pigs weaned per litter	6.4	5.9	6.3	7.7	7.1	6.5	5.9	7.6	7.1	7 0	7 4	6.9	6.5	7.8	7.8	6.0	6.5
Income per farm reporting	$ 1,435	$ 2,661	$ 2,768	$ 392	$ 708	$ 1,841	$ 571	$ 417	$ 1,178	$ 1,063	$ 1,092	$ 351	$ 453	$ 353	$ 160	$ 38	$ 48
Sheep:																	
Percent of farms reporting	15	23	24	0	2	32	0	19	8	24	4	0	8	27	19	5	0
Ewes per farm reporting	39	37	34	—	23	50	—	13	36	37	36	—	21	32	21	17	—
Lambs raised per 100 ewes	98	93	105	—	91	99	—	88	101	101	82	—	99	96	88	112	—
Income per farm reporting	$ 814	$ 782	$ 730	$ 0	$ 378	$ 1,103	$ 0	$ 188	$ 787	$ 688	$ 356	$ 0	$ 376	$ 619	$ 341	$ 260	$ 0
Poultry:																	
Percent of farms reporting	80	86	81	88	93	83	82	73	84	76	76	75	75	91	85	64	52
Hens per farm reporting	130	156	111	91	320	119	112	64	147	74	112	112	65	62	117	83	80
Egg sales per hen	$ 6 03	$ 5.98	$ 6.20	$ 5 73	$ 7.29	$ 6 02	$ 6 32	$ 4 30	$ 4.98	$ 4.65	$ 6.31	$ 6.74	$ 4 52	$ 4.16	$ 6.41	$ 5.09	$ 6.25
Egg sales per farm reporting	783	935	888	592	2.335	713	710	273	731	343	707	756	269	260	752	425	503
Income per farm reporting	227	255	200	73	575	279	126	−27	166	55	274	234	245	65	136	51	64

*T.A. = Tillable acres. **PAU = Productive animal units.

TABLE 9—*Expense and efficiency factors: Labor, machinery, improvements, and other costs by type-of-farming areas in Michigan, 1947*

Type-of-farming areas	All farms	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Number of farms	830	95	78	17	45	149	34	26	83	29	75	24	48	22	27	22	56
Gross income per tillable acre	$ 70.30	$ 75.68	$ 65.35	$109.22	$ 90.47	$ 70.87	$ 73.06	$ 55.31	$ 84.06	$ 58.02	$ 60.50	$114.41	$ 42.12	$ 55.03	$ 41.61	$ 87.56	$ 78.15
Total expenses per tillable acre*	47.44	46.67	43.16	98.55	63.72	43.51	49.59	40.83	50.84	42.24	45.62	90.65	34.79	40.59	28.96	58.92	63.53
Total expenses*	6,365	7,043	7,623	9,057	7,678	7,031	7,639	6,874	6,419	5,020	5,351	8,884	4,520	4,029	3,813	5,008	4,027
Man labor:																	
Number of men	1.7	1.6	1.7	2.3	1.8	1.7	2.1	1.7	1.7	1.7	1.5	2.9	1.6	1.5	1.4	1.7	1.5
Work units per man	267	330	320	—	289	319	254	301	271	261	271	—	261	219	233	273	211
Hired labor	$ 634	$ 454	$ 578	$ 2,131	$ 709	$ 550	$ 1,749	$ 716	$ 538	$ 270	$ 336	$ 2,653	$ 422	$ 495	$ 254	$ 654	$ 286
Family labor	468	524	505	229	488	484	377	557	572	572	461	479	362	217	283	307	488
Operator's labor	1,407	1,440	1,495	1,476	1,515	1,481	1,415	1,472	1,443	1,287	1,410	1,341	1,295	1,242	1,253	1,302	1,202
Man labor cost per tillable acre	18.70	16.02	14.60	41.74	22.51	15.56	22.98	16.31	20.22	17.92	18.81	45.53	16.00	19.68	13.60	26.63	31.18
Power and machinery:																	
Percent without horses	50	69	55	35	40	51	44	19	60	24	48	71	37	32	33	32	59
Investments	$ 3,315	$ 3,419	$ 3,353	$ 3,544	$ 3,497	$ 3,456	$ 3,633	$ 3,554	$ 3,432	$ 2,707	$ 2,959	$ 4,106	$ 2,756	$ 1,987	$ 2,288	$ 2,629	$ 2,059
Annual expense	1,162	1,395	1,313	1,343	1,163	1,287	1,322	1,261	1,317	1,043	1,019	1,382	903	734	727	911	643
Expense per tillable acre	8.66	9.24	7.43	14.61	9.65	7.97	8.59	7.49	10.43	8.78	8.69	14.13	6.95	7.40	5.52	10.72	10.14
Improvements:																	
Investment (less house)	5,183	5,953	5,375	5,389	5,139	5,962	6,704	6,285	5,673	3,813	3,920	4,820	2,749	2,836	2,473	3,412	2,428
Investment per animal unit	174	162	147	—	186	175	225	194	225	132	164	—	129	125	141	134	135
Annual expense	349	429	411	459	340	447	460	350	398	288	265	355	187	227	176	239	165
Expense per tillable acre	2.60	2.84	2.32	5.00	2.82	2.76	2.98	2.08	3.15	2.42	2.26	3.63	1.44	2.29	1.34	2.81	2.59
Feed bought, total	1,231	1,474	1,900	1,047	2,315	1,498	968	1,418	1,027	778	1,029	738	544	512	542	950	765
Per tillable acre	9.17	9.77	10.76	11.39	19.21	9.27	6.28	8.42	8.14	6.54	8.77	7.55	4.19	5.15	4.11	11.18	12.08
Crop expense, total	770	896	993	1,979	754	854	909	706	740	541	575	1,550	607	429	386	394	310
Per tillable acre	5.74	5.94	5.62	21.53	6.26	5.28	5.90	4.20	5.86	4.55	4.90	15.86	4.67	4.33	2.94	4.63	4.90
Taxes, total	128	182	164	179	130	174	143	124	154	77	83	96	71	54	60	76	40
Per tillable acre	.96	1.21	.93	1.95	1.08	1.08	.93	.73	1.22	.65	.71	.98	.55	.54	.45	.89	.63
Other expenses, total	216	249	264	214	264	256	296	270	230	164	173	290	129	119	132	175	128
Per tillable acre	1.61	1.65	1.50	2.33	2.19	1.59	1.93	1.60	1.82	1.38	1.48	2.97	.99	1.20	1.00	2.06	2.01

*Includes operator's and family labor but not interest on investment.

THE BABCOCK FAT TEST OF RECONSTITUTED MILK

By G. M. TROUT, J. ROBERT BRUNNER, and P. S. LUCAS
SECTION OF DAIRY

THE BABCOCK TEST has been used for making fat determinations of reconstituted milk, the same as the manner used for whole milk. The resulting fat tests have seemed lower, however, than the calculated values based upon the fat content of the dried whole milk as determined by the Mojonnier method. Consequently, control officials, relying upon the Babcock fat tests of the reconstituted product, sometimes insist upon a higher fat content in the reconstituted product or discredit the original dried milk as having a lower fat content than analyses show.

Inasmuch as increasing quantities of dry milk are being used in, and sold as, reconstituted milk and that few data are available bearing directly upon the subject, it seemed expedient to make a study of the Babcock fat test of reconstituted milk to determine the relationship of the fat content with that obtained by the Mojonnier method.

PROCEDURE

Samples of dry whole milk from two different sources were obtained, tested for fat according to procedure of the American Dry Milk Institute, Inc., (1947) and reconstituted in distilled water at 68° F., using a Waring food blender. The reconstituted milk was stored 24 hours at 40° F. and then tested by the Mojonnier and Babcock methods. Duplicates were made on each test. In order to minimize sampling errors, test portions were weighed into all the test bottles at one weighing period. Fourteen series were run, using at least 6 different samples of dry milk.

RESULTS

The data secured are presented in Table 1. They indicate that the Babcock fat test always gives lower results than the Mojonnier, actually

ARTICLE 31-21

ranging from 0.10 to 0.50 percent or a percentage range from that obtained by the Mojonnier method from 2.50 to 10.42 percent. The first five series, arranged in order of increasing fat content, and testing under 4.0 percent fat showed slightly less deviation, –0.21 percent, from the average Mojonnier fat test than did the last nine series having 4.0 percent or more fat, which deviated on the average slightly higher, –0.27 percent. The average deviation from the Mojonnier was slightly over 6 percent of the fat present.

Not only were the fat tests lower than those of the Mojonnier but difficulty was encountered also in securing clear tests by the Babcock method. Despite extra precautions in making the test the fat columns often were dark and had charred particles at the base resembling to a remarkable degree ordinary Babcock fat tests of homogenized milk.

DISCUSSION

In light of other studies on comparisons between the Mojonnier and Babcock methods of fat analysis of whole milk the data secured in this study on the Babcock fat test of reconstituted milk are particularly interesting and challenging. For example, many data on

TABLE 1—*Comparison between the Mojonnier and Babcock fat tests of reconstituted milk*

Series	Method				Difference	
	Mojonnier	Babcock			Actual	Percent
	Average 2 Trials	Trial 1	Trial 2	Average		
1	3.08	3.0	2.9	2.95	–0.13	–4.22
2	3.44	3.2	3.0	3.12	–0.32	–9.30
3	3.64	3.5	3.5	3.5	–0.14	–3.84
4	3.83	3.6	3.6	3.6	–0.23	–6.01
5	3.84	3.6	3.6	3.6	–0.24	–6.25
6	4.01	3.9	3.8	3.85	–0.16	–3.99
7	4.00	3.9	3.9	3.9	–0.10	–2.50
8	4.05	3.7	3.7	3.72	–0.33	–8.15
9	4.15	3.8	—	3.8	–0.35	–8.43
10	4.16	4.0	4.0	4.0	–0.16	–3.85
11	4.44	4.2	4.2	4.2	–0.24	–5.41
12	4.80	4.4	4.2	4.3	–0.50	–10.42
13	4.89	4.6	4.6	4.6	–0.29	–5.93
14	5.17	4.8	4.9	4.87	–0.30	–5.80
Average:						
All samples	4.11	....	....	3.86	–0.25	–6.08
First 5 samples	3.56	....	....	3.35	–0.21	–5.90
Last 9 samples	4.41	....	....	4.14	–0.27	–6.12

the Mojonnier-Babcock comparisons appearing in the literature, Herreid (1942), Fahl *et al.* (1938), Hileman *et al.* (1942), Trout and Lucas (1945) and Lucas and Trout (1947), indicate that the Babcock fat test is usually, but not always, slightly higher than that of the Mojonnier.

In this study on Babcock fat tests of reconstituted milk the reverse is true in every case; the reconstituted milk always tested lower by the Babcock method than by the Mojonnier. Thus, the actual difference in fat test between the whole milk and the reconstituted milk made from its dried product would seem to be greater than actually found in this study. The relatively wide variation which seems to exist between the Babcock fat test of whole milk and that of reconstituted milk may call for several explanations. A portion of the difference may be accounted for by the homogenizing effects which are a part of the drying process. This is presuming of course, that the charred, dark, fat columns sometimes encountered in making the test might be attributed in part to homogenization inasmuch as the appearance of the tests were similar to those encountered on homogenized milk. Surveys on fat tests of homogenized milk as made by many investigators indicate that clear fat columns free from char and reading the same as those made on nonhomogenized milk are difficult to secure at best by the Babcock procedure (Trout and Lucas, 1945). In fact, many investigators have come to believe that homogenized milk tests slightly lower in fat, less than 0.1 percent, than the same milk not homogenized. Be that as it may, the possible effects of homogenization cannot account for the wide average difference, 0.25 percent, between the Mojonnier and Babcock fat tests noted in this study. Other explanations must be sought for the existing variations between the tests.

While a lower reading of 0.25-percent fat in the reconstituted milk may seem inconsequential in its commercial application, it assumes a significant role when the results are used to ascertain the percentage of fat in the original dry milk. For example, Swope (1929) outlined a method of testing dry milk for fat by the Babcock method which consisted of mixing 20 grams of dry milk into 140 grams of distilled water, making the regular Babcock test of the reconstituted milk and multiplying the reading by the dilution factor of 8. Thus a low reading of 0.25 percent as noted in the study reported herein actually represents an undervalue of 2.0 percent when one calculates and records the fat content of dry milk by this method of analysis.

SUMMARY

The Babcock fat test for reconstituted milk made from dry milk was found to average 0.25 percent lower than that obtained by the Mojonnier method. Difficulty was encountered in securing clear fat columns free from char. The appearance of the tests were remarkably similar to those often noted on homogenized milk made by the regular Babcock procedure.

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RELATIONSHIP BETWEEN SPEED OF HATCHING AND GROWTH RATE OF CHICKS

By EARL W. HENDERSON[1] *and* LLOYD R. CHAMPION[2]

SECTION OF POULTRY HUSBANDRY

FROM TIME to time, poultry breeders and hatcherymen have discussed whether chicks which hatch first from a setting are superior to those which hatch later. Records of the hatching time, as well as weight records of chicks at several ages, were available from an experiment conducted in 1940. In comparing weights of the chicks at 8 weeks with relative speed of hatching, some association between the two was found. The chicks having a relatively short incubation period tended to be larger at 8 weeks than those with a longer incubation period.

EXPERIMENTAL PROCEDURE

The eggs used in this study came from the following breeds and crosses: Single-Comb White Leghorn, Rhode Island Red, Barred Plymouth Rock, Dark Cornish x White Leghorn, and White Cornish x Barred Plymouth Rock. All eggs were set May 23, 1940, at 8 p.m. in the same incubator. The eggs varied in age from 1 day to 2 weeks at the time of setting.[3] On the eighteenth day the eggs were transferred to hatching compartments. The compartments were opened every 6 hours after the hatch began, and the chicks already hatched were recorded and identified by wing bands.

Chicks emerging during the first 6-hour period ending June 13 comprised emergent group 1, those hatching in the next 6-hour period comprised emergent group 2, and so on to the ninth emergent group. It was assumed that chicks which had not hatched before the tenth 6-hour period would not hatch at all.

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[3]This variation in the age of the eggs may have affected the time required to hatch, but the authors were not aware of data on this subject at the time the eggs were set. It then seemed more important to choose a sample from which the variability within clutches might be determined.

ARTICLE 31-22

TABLE 1—*Sequence of emergence at hatching time and average weight in grams* at 8 weeks*

MALES—EMERGENT GROUP

Breed		1	2	3	4	5	6	7	8	9
D. C. x W. L.	Number	7	10	4	1	....	1	....	1	....
	Average weight	824	824	828	835	....	785	....	835	....
W. C. x B. R.	Number	....	....	....	5	7	10	8	1	2
	Average weight	....	....	....	784	799	788	736	570	765
W. L.	Number	6	5	6	10	....	....	....	....	....
	Average weight	655	662	663	620	....	....	....	....	....
B. R.	Number	2	5	10	7	1	1	....	1	....
	Average weight	705	739	720	674	740	605	....	660	....
R. I. R.	Number	2	15	8	1	1	1	....	1	....
	Average weight	708	662	676	660	605	715	....	725	....

FEMALES—EMERGENT GROUP

Breed		1	2	3	4	5	6	7	8	9
D. C. x W. L.	Number	11	9	5	2	1	1	1	....	1
	Average weight	706	695	711	725	625	645	665	....	725
W. C. x B. R.	Number	....	....	....	7	5	8	8	1	....
	Average weight	....	....	....	688	661	673	648	555	....
W. L.	Number	5	15	7	3	....	1	....	....	....
	Average weight	575	545	532	505	....	550	....	....	....
B. R.	Number	6	9	6	4	....	....	....	....	....
	Average weight	631	651	649	569	....	....	....	....	....
R. I. R.	Number	9	6	7	1	2	1	....	....	....
	Average weight	582	637	579	585	495	480	....	....	....

*454 grams = 1 pound, approximately.

An attempt was made to provide the same environment for the chicks. They were brooded together, fed the same diet, and given access to the same range.

Data for the various emergent groups, arranged according to breed and sex, are given in Table 1. The nine columns in that table represent the nine emergent groups; in each column the number of chicks included in that group and the average weight of the chicks at the end of 8 weeks are given. As an example; in the first male emergent group, there were seven D.C. x W.L. chicks hatched in the first 6-hour period, and their average weight at 8 weeks of age was 824 grams. No W.C. x B.R. chicks hatched until the fourth 6-hour period, when five chicks hatched. Their average weight at 8 weeks of age was 784 grams.

Data for the chicks are separated according to sex, because it is

well known that the average weight of male chicks is greater than that of females at 8 weeks of age, regardless of speed of hatching.

Since the average weight of the various breeds may differ for genetic reasons independently of speed of hatching, the data are also separated according to breeds. The breeds are indicated in the table by abbreviations as follows: D.C. x W.L. indicates chicks hatched from a Dark Cornish-White Leghorn cross. W.C. x B.R. is used to designate White Cornish-Barred Plymouth Rock progeny. W.L. designates Single Comb White Leghorn; B.R., Barred Plymouth Rock; R.I.R., Rhode Island Red.

Because of the relatively small numbers of chicks of the different breeds, the average weights should not be considered as representative of any particular breed or cross in general, nor even of the same breed or cross which may have been grown at another time.

INTERPRETATION OF RESULTS

The association between two characteristics such as hatching speed and weight at 8 weeks is not always evident from a table of averages such as Table 1. A better way to measure the degree of association is to calculate how well the two characteristics keep in step, so to speak.

If there is a perfect correlation between speed of hatching and rate of growth, the chances of success are 100 percent, of course. Perfect correlations are seldom found, and there were none in these data. In fact, the degree of association is not significant except for the female Rhode Island Reds. The list of the correlations between hatching speed and weight at 8 weeks is as follows:

D.C. x W.L. Males	–.07	R.I.R. Males	–.12
D.C. x W.L. Females	–.12	R.I.R. Females	–.47
W.C. x B.R. Males	–.27	All Males	–.10
W.C. x B.R. Females	–.26	All Females	–.34
W. L. Males	–.23		
W.L. Females	–.23		

All the trends were negative. In other words, the longer the time required to hatch, the less the weight at 8 weeks. However, only one correlation is significant, i.e., that for the Rhode Island Red females. This is not apparent in Table 1. Lack of significance may result from the small number of chicks included in the study.

The question might be raised as to how the weights of the chicks in the first half of a hatch might compare with those in the second half. For the D.C. x W.L. males, the average weight of the first 12 chicks to hatch was 824 grams at 8 weeks and that of the next 12 was identical. This result was indicated by the low correlation coefficient (—.07), which is not significant. For the W.L. males, the average weight of the first 11 chicks was 658 grams and that of the next 16 chicks was 636 grams. For the R.I.R. females, where the highest correlation was found (—.47), the average weight of the first two emergent groups, 15 chicks, was 604 grams, and that of the rest was 555 grams.

RELATION BETWEEN SPEED OF HATCHING AND OTHER CHARACTERISTICS

At the Massachusetts Agricultural Experiment Station, Hays (1941) studied the relation of length of incubation period to a number of criteria including body weight at 6 months and at sexual maturity, and age at sexual maturity. He stated that "the length of the incubation period does not affect body weight of pullets at 6 months of age." With respect to weight at sexual maturity, Hays stated that "the pullets in the last five emergent groups were heavier than those of the two earliest groups, but there was no significant difference in body weight among the last five groups." With respect to age at sexual maturity, Hays found "two very early emerging groups averaged about ten days younger than those from the five later groups." With one exception, there was a consistent increase in mean days to maturity with incubation time apparent in Hays' data. One of the most significant phases of Hays' report seems to be the higher production obtained consistently from the early emergent groups. The range in average eggs per hen per year is 248 to 193. Hays' data included records from 937 pullets.

From a much smaller sample, Henderson (1944) found little significant correlation between time in days required to hatch and age at maturity of pullets. The authors are not aware of published data from which the relationship between time required to hatch and earlier developmental criteria might be established. Both age at maturity and time required to hatch are known to be affected by a

number of environmental as well as inherent factors. The environment of eggs in the same compartment of an incubator has been considered reasonably uniform by previous standards. However, the usual range environment for developing a flock of pullets to maturity may lack sufficient uniformity. The age-at-maturity criterion is subject to error because of possible failure to trap a bird when she lays her first egg. Growth-rate criteria, such as weight at a selected age, are generally accepted as inherent indices, when chicks are subject to a reasonably uniform environment. There may be some variation in ideas of what constitutes the same environment, but hatching at the same date, growth in the same flock, feeding and access to the same feed are generally accepted as essential.

Although the results of Hays (1941) and Henderson (1944) did not seem to offer a great deal of promise of the possibility of using hatching rate as a criterion of selection, there was some favorable evidence. At any rate it seemed worthwhile to continue exploring possibilities further with a different and less homogeneous population. With some growth criteria, the relative length of time of the influence of the environment may operate to nullify inherent relationships. Days to maturity may be subject to such conditions. The time of incubation period, while subject to precise controls, is relatively short as compared to the time required for maturity. Even in the relatively short time required for incubation, the uniform environment of the incubator seems to nullify known genetic variation to some extent. Henderson (1930) found little difference in embryonic growth rate among several strains of White Leghorn, Dark Cornish and reciprocal crosses of the two breeds, but genetic differences in subsequent growth criteria are well known. It is also well known that chick weight at hatching is influenced by egg weight and that day-old chick weight is a poor index of adult weight.

SUMMARY

An investigation was made of the relationship between the length of incubation period for chicks of several breeds and the weight of the chicks at 8 weeks of age. Chicks emerging first showed a tendency to be heavier at 8 weeks of age than those emerging later, but in only one group was the correlation sufficiently high to be significant.

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RECENT DEVELOPMENTS IN UNITED STATES SUGAR POLICIES

By LAWRENCE W. WITT
SECTION OF ECONOMICS

THIS ARTICLE discusses recent legislation and administrative decisions affecting sugar. It analyzes the effects of these actions on prices received by Michigan sugar beet producers and on their principal foreign competitors, the Cuban sugar cane producers.

The most important legislation is the Sugar Act of 1948, in effect until 1953. This act, similar to that of 1937, establishes quotas for all areas supplying sugar to the United States. The Geneva Trade Agreements provide that the tariff on Cuban sugar be reduced by 25 cents per 100 pounds. The Philippines Trade Act of 1946, passed as part of the independence program, includes a number of provisions on sugar.

RECENT LEGISLATION AND AGREEMENTS

As part of the Geneva Trade Agreements, the United States and Cuba agreed to a series of tariff reductions on commodities traded between the two countries. One of the concessions made by the United States was the reduction of the tariff on sugar coming from Cuba from three-fourths to one-half cent per pound; basis sugar testing 96° by the polariscope. Since the United States and Cuba each enjoy a 20 percent lower tariff in the other's market under the Platt Amendment of 1903, the U. S. tariff on sugar from other countries is correspondingly higher. An additional tax of one-half cent per pound is charged on all sugar, domestic and foreign, under the internal revenue code.

The Philippines Trade Act of 1946 includes a number of provisions on sugar. Prior to independence, Philippine sugar entered free of duty as produce of a territorial possession of the United States. Until July 3, 1974, a maximum quota of 982,000 short tons (850,000 long tons,

ARTICLE 31-23

raw value) may be shipped annually but subject to gradually increasing percentages of tariff duties. In 1974, the full rate of duty (higher than Cuba) will be charged and the quota provisions expire.

Under the Sugar Act of 1948, quotas were changed from a percentage basis to specific quantities. As in the Sugar Act of 1937, the Secretary of Agriculture must determine the sugar requirements for the United States, for Puerto Rico, and for Hawaii. The act specifies a number of factors to be considered in establishing requirements. These include recent consumption, inventories, population changes, demand conditions, the welfare of the domestic sugar industry and prices not excessive to consumers. (The latter wording is new.) The 1948 act provides further that consideration be given to the relationship between wholesale prices for sugar and the general cost of living currently and in relationship to 1947 under price control. (This suggests that the Secretary should consider having sugar prices go up and down at about the same rate as the cost of living.) There is a considerable latitude for administrative decision with respect to the basic sugar requirements. Once requirements have been determined, the formula is quite definite.

The United States and possessions are allocated a basic annual production quota of 4,268,000 short tons, apportioned by areas as shown in Table 1. The Philippines are given 982,000 short tons, as specified in the Philippines Trade Act. Of the amount then remaining, 98.64 percent is allocated to Cuba, and 1.36 percent to foreign countries other than Cuba and the Philippines. Thus, Cuba becomes a residual claim-

TABLE 1—*Allocation of sugar quotas to various producing areas in accordance with different estimated consumption requirements for continental United States*

Producing area	Official allocations*			
	Basic quota	Jan. 7, 1948 7,800,000 Short tons	June 7, 1948 7,000,000 Short tons	Aug. 10, 1948 7,200,000 Short tons
Domestic beet	1,800,000	1,847,738	1,847,738	1,847,738
Mainland cane	500,000	513,260	513,260	413,260
Hawaii	1,052,000	900,000	900,000	825,000
Puerto Rico	910,000	934,134	934,134	982,436
Virgin Islands	6,000	6,159	6,159	6,159
Philippines	982,000	290,000	290,000	240,000
Cuba	(Min.) 28.6%	3,239,429	2,450,309	2,821,787
Other foreign	Less than 1%	69,280	58,400	63,620

*Because production would not reach quotas, reductions were made for mainland cane producing areas, Hawaii and the Philippines, and re-allocated to other areas.

Sources: Sugar Act of 1948; Federal Register; U.S.D.A. News Releases for February 26, June 7, July 12, and August 10, 1948.

ant. If United States consumption is high, Cuba's quota will be a considerable quantity; if consumption is low, Cuba's quota will be small.

Provisions are made for re-allocating quotas assigned to each producing area in case of deficits in production. Cuba is assigned a considerable part of such deficits, 95 percent if from the Philippines. When Cuba's total quota, including re-allocations, falls to 28.6 percent of estimated continental United States consumption, it becomes necessary to reduce the quotas of domestic producers. Only in this case are basic quotas for United States areas reduced.

On January 7, 1948, the Secretary of Agriculture announced estimated consumption requirements for continental United States at 7,800,000 short tons. On February 26, this was cut to 7,500,000 short tons and on May 26 was further reduced to 7,000,000 tons. Prices of sugar in the United States rose following this action. On August 10, the quota was increased to 7,200,000 short tons. Neither Hawaii nor the Philippines are expected to meet their quotas, and part of their quotas have been re-allocated. More recently, 100,000 short tons of mainland cane quotas were re-allocated.[1]

RECENT PRODUCTION TRENDS IN U. S. AND POSSESSIONS

It is of interest to relate the basic quotas allocated to the various producing areas to the levels of production actually attained by them

TABLE 2—*Production of sugar, raw value, in various United States producing areas for indicated years (in thousands of short tons)*

	1930-34	1935-39	1940-44	Basic quotas	Largest year
Domestic beet sugar	1,396	1,520	1,453	1,800	1,897—1940
Mainland cane sugar	236	474	429	500	583—1938
Hawaiian Islands	1,042	980	920	1,052	1,087—1933
Puerto Rico	902	974	961	910	1,148—1941
Virgin Islands	3	6	4	6	8—1936 1940
Totals	3,571	3,960	3,767	4,268	4,265—1939
Philippines Islands	1,177	1,127	438	982	1,653—1933

Source: The World Sugar Situation, Bureau of Agricultural Economics, U.S.D.A. September 1947. Mimeo.

Note: Deductions for domestic consumption must be made from the estimated production of the Hawaiian Islands, Puerto Rico, Virgin Islands, and the Philippines. These have been estimated for 1947 at 120,000 tons for Puerto Rico, and 45,500 tons for Hawaii.

[1] On October 10, 100,000 short tons were subtracted from the domestic beet sugar area and re-allocated to Puerto Rico (25,825 short tons) and Cuba (74,175 short tons). Thus at this date, only Puerto Rico and the Virgin Islands are expected to fill their quotas. The aggregate deficits of over one million tons for continental United States, Hawaii, and the Philippines have been allocated to Cuba.

in various years. These are shown in Table 2. It is evident that the basic quotas have been set at levels above the sustained historical levels of production. Individual years show higher production for each area than the basic quotas, but not all during the same crop year. The conclusion is inescapable; the quotas are at or near the maximum recent production. Thus, in most years, the act permits an expansion of the level of sugar production within the United States and territories; and thus, is an instrument for greater self-sufficiency.

The Sugar Act of 1948 is only one of a series of laws having similar effects. Sugar imports have been subject to various levels of tariffs for a long period of time. Since 1934 subsidy payments to growers have been made subject to certain rules.[2] Many reasons have been cited for these legislative acts. One reason is of particular interest at this time.[3] It is argued that sugar should be produced domestically even at higher cost in order to provide sugar supplies at times of international crises. Domestic areas which have benefited from these policies of providing financial incentives for sugar production are listed in Table 2. All show lower production in war than in pre-war years. The Philippines received special advantages in tariff exemption during the pre-war period yet were completely cut off during the war years. Hawaii, Puerto Rico, and the Virgin Islands also received advantages compared with Cuba and other foreign countries. All show declines for 1940-44. These are partly due to unfavorable climatic conditions, military competition for labor, and increased need for and competition from other crops.

Regardless of the reasons, the fact remains that production was not available in increased amounts when needed. The result was sugar rationing, coupled with increased dependence on Cuba. The proportion of total United States sugar supplies coming from Cuba increased from about 30 percent pre-war, to a high of 55 percent in 1943 and 1944.

Were it not for this increased importation from Cuba, an increase in annual imports from 1,961,000 short tons in 1935-39 to 2,918,000 short tons in 1940-44 (a high of over 4 million tons in 1944) sugar rationing would have been far more severe.

PRODUCTION TRENDS IN CUBA AND THE PHILIPPINES

In contrast to the production trends in the United States and possessions, Cuba greatly expanded her production, although not as

[2]In 1934 and 1935 these were made under the old agricultural adjustment program; in 1936 and 1937, under conservation payments; and beginning in 1937, under the Sugar Act of 1937. The Commodity Credit Corporation has made additional support payments beginning in 1943.

[3]For a more detailed and critical discussion of the political background of the legislation, see W. C. Pendleton, "American Sugar Policy, 1948 Version," *Journal of Farm Economics*, May 1948.

TABLE 3—*Average production of sugar in Cuba, raw value and price in New York*

Crop years	Production	Price in New York (calendar year)
	thousands of short tons	cents per pound
1925-29	5,295	2.50
1930-34	2,847	1.29
1935-39	3,183	2.30
1940-44	3,685	2.67
1945	4,476	3.42
1946	6,448	4.61
1947	6,675	5.46

New York price, cost and freight paid, but before tariff was paid. Crop year with harvesting season beginning in fall or early months of the following year.
Source: The World Sugar Situation; U.S.D.A., September 1948.

rapidly as the market demand. Cuba's production (Table 3) dropped from the high levels of the 'twenties as the world price and purchasing power declined and as Cuba imposed production restrictions in an attempt to adjust production more nearly to possible sales. Throughout the 'thirties, world and Cuba sugar supplies were large and burdensome.

During the war years, Cuban production increased, particularly in the 1943 crop year. By 1946 both acreage and production were at all-time highs, more than twice the pre-war levels and above those of the 'twenties. The existence of unused plant capacity in the 'thirties, of course, facilitated the expansion of production during the later war period.

In spite of these wartime contributions by Cuba the amount of sugar which she may sell to the United States is limited by the new law. A minimum sale of 28.6 percent of United States consumption is guaranteed, but Cuba has been providing 45 to 55 percent of United States supplies. Even in 1948 it has been necessary to increase the amount purchased from Cuba because Hawaii, the Philippines, and United States cane areas are unable to meet their quotas. If these areas expand their production in future years, Cuba's sales will inevitably decline. However, under the Sugar Act of 1937, the percentage was fixed, so the latest legislation is somewhat more liberal.

The sugar industry of the Philippines was thoroughly disorganized by the destruction of mills and refineries, and abandonment during the war. They are producing at less than half of pre-war levels and exporting less than a third of the permitted quota. So long as this

continues, most of the quota is being re-allocated to Cuba. As the Philippines production is restored, Cuba's sales to the United States will decline. Cuban sugar producers may again face serious surplus problems as they did throughout the 'thirties.

ECONOMIC IMPLICATIONS

The effect of the Sugar Act of 1948 is to make United States sugar prices subject to administrative control. Through his authority over quotas, the Secretary of Agriculture has powers to increase or decrease the level of importation and hence, the total supply of sugar available in the United States. The act itself suggests that these decisions should be made so that sugar prices move in some relation with the prices of other commodities in the United States. No requirement is made for giving attention to prices of sugar in the international market. If, as seems likely, world sugar production soon exceeds the ability to purchase (not willingness to consume), international prices are likely to decline and supplies accumulate. In this case, international prices might be declining while United States prices are stable or even increasing.

Prices received by United States sugar producers probably will show considerable stability for the duration of the 1948 Sugar Act. The degree of stability will depend on whether the estimates of sugar requirements are relatively liberal or relatively conservative.[4] Undoubtedly, political motives will affect the decisions, as will the activity of producer, processor, and consumer pressure groups.

Cuban producers on the other hand, have already seen the United States market restricted. From January to June it was decreased by nearly 800,000 short tons, but nearly half of it was restored by August. If the Philippines and Hawaii increase production, Cuba's sales will be further restricted in later years. Each sugar mill in Cuba has a quota in the United States market. In this way, each of them receives some benefits of the higher United States price.[5] However, as the proportion sold to the United States decreases, a larger proportion must be sold in the less profitable international market and their net income and average price will decline.

Under this system of United States' and Cuban rules, the tariff reduction of one-fourth cent per pound goes to the Cuban producers

[4] The original estimate on January 7, 1948, was liberal; the estimate on June 7, 1948, was relatively conservative. On August 10, 1948, the quota was increased somewhat.

[5] For a short period in the spring of 1948 the usual premium for quotas in the United States market was absent.

as an increased price for sugar sold to the United States or will be divided between Cuban mills and United States processors. It is unlikely that any part of the decrease will be passed on to the United States consumers. Meanwhile, the United States government loses the revenue (some $14,000,000 in 1948) it would otherwise obtain from the higher tariff.

Does Cuba have more dollars to spend in the United States for pork, lard, automobiles, machinery, and other export goods which directly benefit producers or indirectly would benefit the United States consumer through an increase in income or employment? The direct effect of the tariff reduction is to provide more dollars to Cuba. The direct effect of the Sugar Act of 1948 is to reduce sugar sales to the United States and hence dollar receipts by Cuba.[6] Temporarily, the United States, through the Commodity Credit Corporation is purchasing additional amounts of sugar (about one million short tons) to supply occupied Germany and other foreign areas, and are paying for it in dollars. While this continues Cuba will have a large supply of dollars to spend in the United States. Ultimately, it means less trade in both directions.

While short-time prospects for Cuba are favorable, the long-time prospects for sugar are not so favorable. As Cuban producers come face to face with declining outlets for sugar, a substantial discrepancy between United States and international sugar prices probably will develop. This may foster serious problems in the United States. Certainly, Cuba will face economic and political problems of serious consequences.

SIGNIFICANCE TO MICHIGAN PRODUCERS

The acreage of sugar beets harvested in Michigan has varied from a high of 154,000 acres in 1933, to a low of 48,000 acres in 1943. Since 1943 the acreage has been relatively low. The post-war peak was 95,000 acres in 1946.

The interest of farmers in planting sugar beets is influenced by many factors. Among them are the contract price offered, government payments, prices of other farm products, the wages of labor as well as the climatic conditions and nature of their land and farm

[6]It is possible that the quotas might maintain the United States price high enough that the quantity sold in the United States market would bring Cuba an aggregate supply of dollars as large as for a larger export. This is probable only when consumption in the United States is low and quotas for domestic areas are reduced to the same extent as Cuba's. On the other hand, the larger amount of sugar left for Cuba to sell in other countries will further reduce the international sugar price, and Cuba's receipts from other countries.

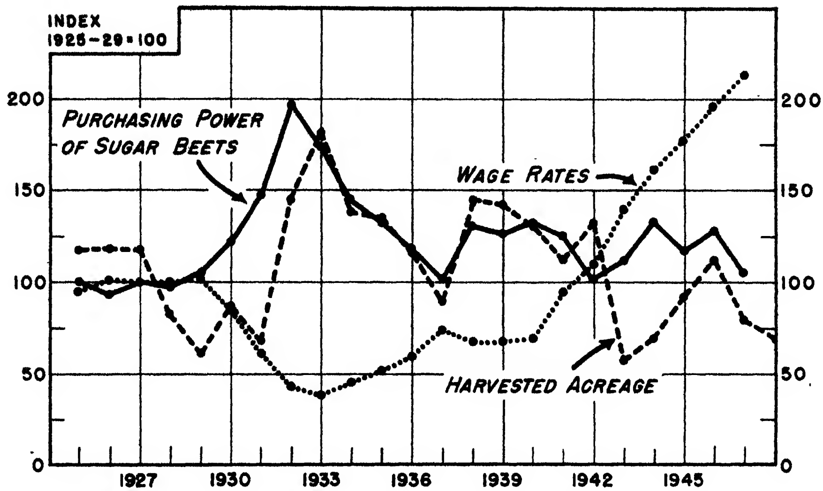

Fig. 1. **Indices of Sugar Beet Acreage, Farm Labor Wage Rates, and Price Ratios Between Sugar Beets and All Farm Prices in Michigan, 1925-1948.**
Source: Based on data in Appendix Table 1.

organization. Figure 1 shows prices of sugar beets relative to other farm prices, as compared with harvested acreage and wage rates.[7] Acreage of beets increased as price ratios increased and declined as price ratios declined. (See Table 4 for actual data.)

In the early depression years sugar beet prices declined less than other prices; hence the purchasing power of sugar beets was relatively high and many farmers increased beet production. From 1933 to 1942 acreage and purchasing power of beets moved closely together. Since then acreage has not responded to the fairly favorable price ratios, probably largely because of higher farm labor costs and the greater difficulty of obtaining an assured supply of labor. Subsidies paid by the AAA are not included. The addition of these subsidies to the price indicates an even more unfavorable response by Michigan farmers to the production of sugar beets.

Michigan farmers find other crops more profitable than sugar beets, even with the subsidies being paid and tariffs levied by the federal government. If these subsidies were removed, most farmers would shift rapidly to other crops; in fact, a large number of farmers have

[7]Figure 1 shows relationships by a series of index numbers. All figures are based on the 1925-29 average. The index of sugar beet prices divided by the level of all farm prices gives the purchasing power of beets. When sugar beets are high relative to all farm prices the purchasing power of beets is above 100.

already shifted. It is estimated that only about 59,000 acres of sugar beets were harvested in 1948.[8] In most western states acreage has been stable or increasing.

Three generalizations for Michigan are warranted. 1) In spite of considerable tariff protection and subsidies sugar beet prices have not induced Michigan farmers to make the necessary labor contracts and other adjustments necessary to produce more sugar beets. Many farmers shifted to the production of other crops. 2) If it becomes necessary to establish state and farm quotas as provided under the Sugar Act of 1948, Michigan does not have as strong an argument for substantial quotas as other states. 3) Considerable doubt exists as to whether the agriculture of the state, or the state as a whole, derives any net benefit from the sugar legislation now in effect. If the effects on exports and on international political relations are considered the benefits to Michigan are even more questionable.

TABLE 4—*Acreage and prices of sugar beets in Michigan, indices of sugar beet acreage and prices, farm wages, and of all farm products, 1925-1948 (1925-29=100)*

Year	Acreage harvested	Index of acreage	Price to grower*	Index of beet prices	Index of all farm products	Beet prices** all prices	Index of farm wages
1925	99,000	118	$ 7.05	97	96	101	95
1926	100,000	119	7.00	96	102	94	101
1927	99,000	118	7.16	98	97	101	101
1928	71,000	84	7.22	99	102	97	100
1929	52,000	62	7.94	109	103	106	102
1930	74,000	88	8.08	111	90	123	85
1931	58,000	69	6.33	87	59	147	62
1932	122,000	145	5.73	79	40	198	44
1933	154,000	183	5.81	80	46	174	39
1934	117,000	139	5.92	81	56	145	45
1935	114,000	135	6.29	87	65	134	52
1936	98,000	116	6.45	89	75	117	60
1937	76,000	90	6.17	85	83	102	75
1938	122,000	145	6.08	84	64	131	68
1939	120,000	143	5.59	77	61	126	68
1940	112,000	133	6.34	87	66	132	70
1941	94,000	112	7.43	102	81	126	89
1942	112,000	133	7.49	103	101	102	109
1943	48,000	57	10.20	140	126	111	140
1944	59,000	70	12.10	166	125	133	162
1945	78,000	93	11.10	153	132	116	177
1946	95,000	113	14.10	194	151	128	196
1947	67,000	80	14.10	194	184	105	214
1948	59,000(est.)	70					

Sources: Crop Reports for Michigan, United States Department of Agriculture in cooperation with Michigan Department of Agriculture; Michigan Farm Economics.

*Includes Commodity Credit Corporation support prices from 1943 on.

**The index of sugar beet prices was divided by the index of all farm prices. This gives a ratio of comparative profitability (on the chart, this is called Purchasing Power of Sugar Beets.) When the resulting ratio is over 100, sugar beets are more favorable relative to other farm products than in the base period 1925-29; when it is below 100, price ratios are less favorable to beets.

[8]Nov. Crop Report, Michigan Cooperative Crop Reporting Service, Lansing, Nov. 12, 1948.

CONCLUSIONS

The effect of the Sugar Act of 1948 is to freeze overall patterns of production as between beet areas and cane areas, and between continental and off-shore United States producing areas. Quotas established by the act will permit some increase in the *average* level of production in United States areas as compared with pre-war. Wartime shifts in production are not adequately reflected in quota provisions.

As before, the Philippine Republic and Cuba have preferred positions in the United States market compared with other foreign producers. However, Cuba must bear the burden of all of the fluctuations in the level of sugar consumption in the United States. If United States consumption drops very substantially, domestic producers share a small part of the reduction.

The recent reduction in sugar tariffs is largely a transfer of income from the United States government to Cuban sugar producers. Because of the quotas limiting imports the usual result of increased imports and lower prices is not occurring.

Other arrangements such as sales to Europe via United States relief agencies will probably prevent any immediate price collapse for Cuban sugar producers. Dollars will also be available to continue purchasing export commodities in the United States. However, the long-run prospects are for declines in Cuban exports, international sugar prices and a reduction in Cuban-American trade.

Sugar producers in Michigan probably do not face any further serious price declines for sugar. However, it is likely that when the Sugar Act expires in 1953 international prices will be considerably below comparable United States prices. It must be recognized that sugar prices will be subject to administrative and political manipulation. While prices are likely to be more stable than for most farm products they are vulnerable to sharp changes in political attitudes, such as might happen if the Sugar Act were not renewed in 1953. While it may be profitable to produce sugar beets while the Act is in effect, it is desirable to study the profitableness of other alternative crops.

The record of sugar beet production in Michigan indicates that price relationships profoundly affect the acreage of beets harvested. When prices of sugar beets are high relative to all agricultural com-

modities, acreage increases; when sugar beet prices are low relative to other agricultural products acreage declines substantially. A high farm wage rate also discourages sugar beet production. With the relatively high prices for wheat, corn, beans, and dairy products since the war and relatively high wage rates many Michigan farmers have preferred to produce other products.

HARVESTING LADINO CLOVERSEED WITH A VACUUM HARVESTER

By W. H. SHELDON *and* S. T. DEXTER
SECTIONS OF AGRICULTURAL ENGINEERING AND FARM CROPS

IN MICHIGAN and neighboring states the interest in Ladino clover as a forage crop is constantly increasing. Although the crop can be grown easily, seed is scarce and high priced. An important problem is that of harvesting the seed.

In preparation for a seed crop, the first cutting is removed from the field usually before June 5. This decreases weediness, eliminates most of the Alsike clover and gives a uniformly more matured seed crop ripening during late July or early August. This is the most favorable time for drying vegetative material in the swath. When cut for seed, the vegetation is from 4 to 6 inches tall, with many of the seed-heads bent over almost to the ground; growth of green material is continuous if there is sufficient moisture in the soil and the seed, when ripe, threshes out very easily. These conditions make the harvesting of Ladino cloverseed difficult and inefficient when using the usual grass seed harvesting equipment.

Experimental work begun at Michigan State College in 1944 indicates that a vacuum-type harvester recovers more Ladino seed than other methods. Two previous reports have been made on this method of harvesting white cloverseed. Dexter and McKibben,[1] in February 1945, reported preliminary trials and made recommendations for rebuilding the equipment. Dexter and Sheldon[2] reported, in May 1947, results with the enlarged and improved machine. The vacuum harvester consists of an exhauster-type blower mounted on a tractor and belt driven by the tractor engine, a rotating beater contained within a suction nozzle and attached to the suction side of the blower with a

[1]Mich. Agr. Exp. Sta. Quar. Bul., Vol. 27, No. 3, Feb. 1945.
[2]Mich. Agr. Exp. Sta. Quar. Bul., Vol. 29, No. 4, May 1947.

ARTICLE 31-24

12-inch tube. Another 12-inch tube connects the discharge side of the blower to a trailing wagon with tight sidewalls. The top of the wagon is covered with burlap to prevent seed from blowing out. The suction nozzle of the harvester is 6 feet wide to take a normal swath. The blower is rated to move approximately 5,000 cubic feet of air per minute with sufficient vacuum to raise water 10 inches and uses 15 horsepower.

Further experiments on a larger scale were carried on in 1948 to obtain data in the field. A field of 12.1 acres was divided into 3 areas and harvested by different methods to obtain comparative data with the following methods and results:

Method of harvest	*Seed recovered per acre*
Area 1—Combining from windrows	100 pounds per acre
Area 2—Combining from swaths	60 pounds per acre
Area 3—Vacuum harvest from swaths	160 pounds per acre

Re-harvesting portions of these three areas with the vacuum harvester obtained approximately 40, 20, and 7 pounds of seed per acre from the respective areas.

A total of 1,485 pounds of Ladino cloverseed was harvested by the various methods. This is an average of 122.7 pounds per acre for the entire field of 12.1 acres. All of the weights given are for the recleaned seed.

TABLE 1—*Harvesting data*

Area	Acres	Harvesting method	Acres harvested per hour	Amount of seed, in pounds	Amount of seed recovered per acre, in pounds
No. 1	1.13	Combined from windrows	.6	114	101
		Vacuum reharvest—1.13 acres	1 0	47	41.6
No. 2	5.86	Combined from swaths	.6	351	60.0
		Vacuum reharvest—4.26 acres	1.0	80	21.1
No. 3	5.11	Vacuum harvest from swaths	.5	818	160.0
		Vacuum reharvest—2.13 acres	2.1	15	7.0
Rethreshing of all hay picked up by vacuum on 10.5 acres				50	4.0
Total seed harvested and average from 12.1 acres				1485	122.7

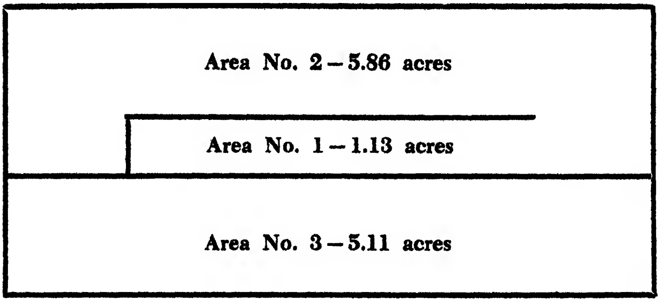

Fig. 1. Field layout – Total area 12.1 acres.

PROCEDURE

Cutting

Cutting started August 13 in the afternoon and continued through the next day to complete areas 2 and 3 (Fig. 1). Area 1 was cut during the late afternoon of August 15 with a windrowing attachment on the mower. The shoes were removed from both ends of the cutter bar for cutting close to the ground. Several sections and guards were broken by small stones.

Harvesting and Threshing

Two combine harvesters were used. A power take-off-driven Allis-Chalmers with a special pick-up attachment was used in the field to pick up windrows from area 1 and swaths from area 2. A McCormick-Deering model 52R, with a mounted engine, was used as a stationary thresher for all hay picked up by the vacuum harvester.

Owing to rapid and irregular feeding, a considerable amount of seed passed over the screens in the stationary combine. All of this hay was rethreshed with the power take-off-driven combine with a reduced cylinder speed and with air shut off. This rethreshing collected several bags of chaffy material from which was salvaged 50 pounds of seed.

The hay after rethreshing was blown into the barn for dairy feed.

A sample of stems contained 9.44 percent protein and 33.83 percent fiber and a sample of the chaff contained 18.06 percent protein and 15.23 percent fiber.

Time Required for Harvesting and Threshing

A total of 11 hours (two long afternoons, August 17 and 18) was required to combine areas 1 and 2, with an average of 0.6 acre an hour. During the same afternoons the vacuum harvester covered 5.11 acres to gather four loads, with 7¾ hours spent in the field loading and 2¼ hours unloading, making a total of 10 hours with an average of one-half acre per hour. Interruptions due to coarse material (bull thistles, wild carrot, etc.) winding around the beater or otherwise clogging the suction nozzle accounted for about half of the time spent in the field gathering the four loads, which averaged 200 pounds of seed per load.

During the afternoon of August 19, area 1 and portions of areas 2 and 3 were reharvested with the vacuum harvester, covering 7.52 acres in 6½ hours (Table 1). This is an average of 2.1 acres per hour on the area previously vacuum-harvested and 1.0 acre per hour in picking up material which had passed through the combine.

Threshing of the hay which had been picked up by vacuum was made more difficult because of the fineness of the material and the dirt picked up with the hay. The threshing rate was about 1½ times as fast as the gathering rate.

SUMMARY

Field trials indicate that, through the use of the vacuum harvester, it is possible to recover a much larger percentage of the seed from Ladino clover than with conventional methods.

This appears to be a practical method of efficiently harvesting Ladino cloverseed and is worthy of further consideration in a grassland farming program.

SEASONAL PRICE VARIATIONS IN MICHIGAN FARM PRODUCTS[1]

By L. L. BOGER[2]
SECTION OF ECONOMICS

THE PRODUCTION of farm products is seasonal, but consumers desire a supply the year around. Consequently, someone must produce or store these products to meet the consumer's needs. Some products can be stored easily and inexpensively, while others are more difficult and costly to store. In general, prices of the major crops grown in Michigan vary throughout the year by the cost of storing from one production season to the next. Livestock prices vary from month to month by the difference in production costs at different times of the year.

The seasonality of production and marketing in the United States as a whole often has more influence on Michigan farm prices than does Michigan production and marketing. Hence, geographic or climatic conditions in Michigan may make it possible for Michigan farmers to market their products during the time of high seasonal prices with no added costs.

Seasonal price movements during World War II were influenced by price controls. These controls altered the amount of seasonal price variation by setting year around ceilings or floors on prices. Since controls have been relaxed, seasonal price movements are again approximating their pre-war patterns.

Several factors, such as weather conditions, business activity, and the trend of all farm prices, affect seasonal price movements in indi-

[1]*Sources of Data.* The Michigan farm prices used in this study were those reported to the office of the State Agricultural Statistician, Lansing, Michigan. Average monthly marketings were computed from data in the same office. Prices from 1910 to 1925 were taken from Statistical Bulletin 15, "Prices of Farm Products Received by Producers, the North Central States," prepared by the Bureau of Agricultural Economics of the United States Department of Agriculture. Cattle prices at Chicago were published by the Production and Marketing Administration of the United States Department of Agriculture. Production data concerning the size of the United States crops by years were taken from various issues of *Agricultural Statistics* published annually by the United States Department of Agriculture. Data on prices received by farmers were taken from "Agricultural Outlook Charts, 1947," prepared by the Bureau of Agricultural Economics of the United States Department of Agriculture.

[2]Acknowledgment is given C. M. Hardin and M. E. Cravens, as well as others of the Agricultural Economics staff, who offered valuable suggestions and criticisms.

vidual years. With some commodities the variation in price from the average seasonal pattern in individual years is quite pronounced, while others have about the same pattern year after year. An average seasonal pattern, which has been adjusted for the trend in prices and price cycles, should not be applied in individual years until adjustments for existing economic conditions as well as probable trends are made.

Seasonal price changes are important to farmers, food processors, marketing agencies, as well as others who buy, sell, or handle Michigan-produced farm products. Each year they are faced with the problem of whether it will be profitable to store or change production schedules in order to realize greater returns. It is often not advisable to produce or store farm products for the highest prices, since the gain in price may be more than offset by the higher costs involved.

Definition of Terms

Index of Irregularity: This is a measure of the amount of variation in the price for a given month from the average price prevailing in that month for the 10 years, 1933-42. Its value corresponds to one standard deviation from the price, and must be doubled to give the range of prices about the average for approximately seven of the ten years.

Large Crop: A large crop was assumed to be one that was 10 percent or more above the average for the 20-year period, 1923-42.

Small Crop: A small crop was assumed to be one that was 10 percent or more below the average for the 20-year period, 1923-42.

Rising Prices: A period of rising prices was assumed when all farm prices rose 10 percent or more in a year. On the basis of this classification, farm prices rose an average of 20 percent per year in six years from 1923 to 1942.

Falling Prices: A period of falling prices was assumed when all farm prices fell 10 percent or more in a year. On the basis of this classification, farm prices fell an average of 23 percent per year in five years from 1923 to 1942.

Monthly Marketings: These figures refer to the average amount of the total annual production that was moved to market by Michigan farmers in a given month. For the more perishable products, such as eggs, and milk, the average amount produced monthly was used as a

guide to marketings. Creamery butter manufactured monthly and corn purchased monthly by elevators were used as an indication of farm marketings for these products.

Average Seasonal Movements of Prices, 1933-42

Table 1 shows the months of highest and lowest prices received by Michigan farmers for 21 commodities as well as the difference in prices among these months for the 10 years, 1933-42. Egg prices had the greatest amount of seasonal variation of the 21 products and averaged lowest in June and highest in November. The total variation was 65 points for eggs as compared with only 9 points for wheat, which had the least amount of price variation. Apples and potatoes, because of their semi-perishable nature, had a large amount of average seasonal price variation while prices for most of the grains that are easily and inexpensively stored had a relatively small amount of variation.

On the average, the seasonal price rise for most of the crops represented about what it costs to store these commodities from one harvest to the next. Storage costs involve allowances for such items as interest charges, insurance, storage space, binning, or cribbing expense, shrinkage and deterioration, and necessary fumigation. Such costs for storing one-dollar wheat for 6 months have been estimated as follows:[3]

	Cents per bushel
Interest (6 months at 6 percent)	3.0
Insurance (6 months)	1.0
Storage space (where proper)	2.5
Binning expense (where proper)	1.0
Shrinkage and deterioration	2- 5.0
Fumigation	0.5
Total	10-13.0

Storage costs tend to vary as a percentage of the price so that the estimated total of 10-13 cents a bushel for storage costs on one-dollar wheat represents 10-13 percent or about 2 points per month. Charges for labor and storage space need not be included as costs if they would be unused otherwise. Omitting these charges, storage costs are reduced to about 1 point a bushel per month. From Table 1, the price rise for wheat averaged 9 points in 9 months or 1 point per month and offset the costs involved. Storage costs for oats, including charges

[3]L. J. Norton, University of Illinois Extension Circular 516—"When Should Grain Be Marketed," July 1942.

TABLE 1—*Months in which highest and lowest prices occurred for 21 commodities, Michigan, 1933-42**

Commodity	Month of lowest price	Month of highest price	Points difference—low to high
Apples	September	May	60
Barley	August	February	13
Beans, field	March	September	13
Buckwheat	November	July	12
Butter	June	December	12
Butterfat	June	December	13
Calves, veal	June	February**	16
Cattle	December	May	13
Chickens	December	April	16
Corn	March	September	18
Eggs	June	November	65
Hay, tame	August	February	16
Hogs	December	September***	22
Lambs	November	March	10
Milk, wholesale	June	November	16
Oats	August	April	14
Potatoes	November	August	52
Rye	June	January	14
Sheep	November	March	20
Wheat	August	May	9
Wool	March, April†	June	10

*Seasonal prices were adjusted for price cycles and trends.
**Veal calves had a minor peak in September, 2 points below February peak.
***Hog prices had a minor peak in March, 10 points below the September peak.
†Lowest price averaged the same in March and April.

for labor and storage space, averaged slightly less than 2 points a month and corresponded very closely with the average seasonal price rise from 1933 to 1942. Corn prices tended to be low from harvest until March; however, the price rise following March was pronounced. When corn is sold on a graded basis, part of the price-advance throughout the season is due to the better grade resulting from shrinkage during storage. Even so, the price rise averaged about the same as the storage costs plus the premium for the higher grade. In 1933 to 1942, this meant that 63-cent corn in November was equivalent to 73-cent corn in the following July.

The average seasonal price rise represented about what it cost to store during the season for most of the major crops except field beans. Table 1 shows that field bean prices averaged lowest in March and highest in September. However, Fig. 1 illustrates the average seasonal movement by months for 1933-42, and includes the zone of irregularity. The average seasonal pattern was very erratic and the variation within the same months in different years was relatively great as indicated by the shaded area in the figure. Because of this wide variation in prices in individual years from the average price for the 10 years, no general rule as to the best time to market beans may be developed.

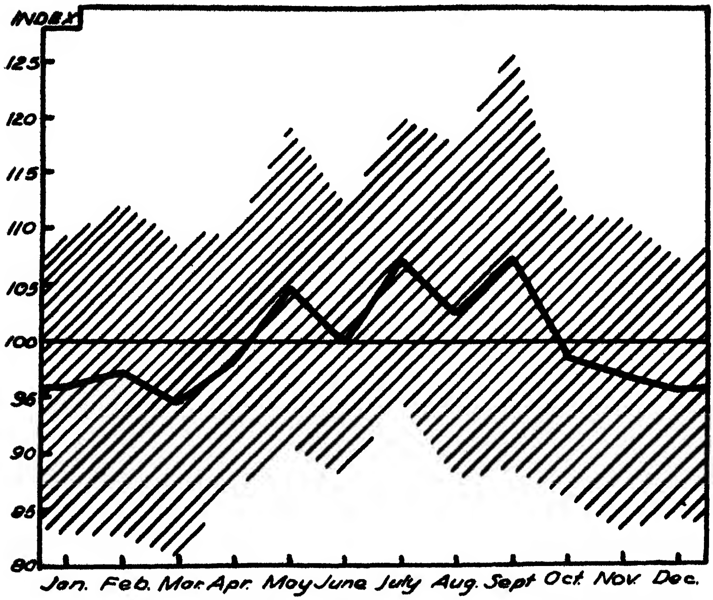

Fig. 1. Field beans: index of average seasonal variation of Michigan farm prices, 1933-42.

The seasonal price pattern of field beans was highly irregular and prices in individual months varied considerably from the average price pattern prevailing in the 10-year period.

Actually, the highest price occurred in eight different months during the 10 years, 1933-42.

In contrast to the wide variation in prices from the average, as was true for field beans, was the small amount of variation from the average exhibited by egg prices. Figure 2 shows the average seasonal price movement for eggs and the zone of irregularity for 1933-42. Here the shaded area is relatively narrow, indicating that prices tended to follow the average seasonal movement closely in most years.

In general, prices of livestock and livestock products tended to follow the average seasonal pattern in individual years more closely than prices of the major crops. Also, the more seasonal price variation that the products exhibited, the more nearly they tended to be repeated year after year.

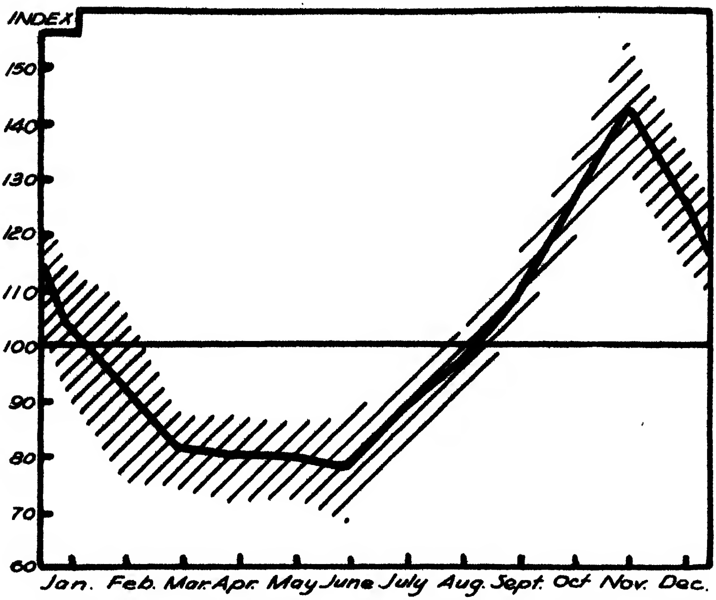

Fig. 2. Eggs: index of average seasonal variation of Michigan farm prices, 1933-42.

The seasonal variation of egg prices was great and prices during the 10 years were near the average price pattern in most years.

Significant Monthly Price Movements, 1923-42

The movements of prices from one month to the next were analyzed for the 20 years, 1923-42 to determine whether prices in any month were consistently higher or lower than prices in the preceding month. In order for the movement to be significant, prices had to move either upward or downward in at least 15 of the 20 years.[4] Prices for all the products except wool exhibited significant downward trends in at least one month of the year (Table 2). For field beans, cattle, lambs, and wool, there were no months that prices showed a significant upward movement from the preceding month. Milk prices, however, rose each month from the preceding month from June through November, and fell each month from the preceding month from December through June. In other words, the monthly movement of milk prices tended to be the same year after year, while the

[4]The Chi square test of significance was used.

TABLE 2—*Months when the movement of farm prices from the preceding month were significant, 20 products, Michigan 1923-42*

Commodity	Months of significant movements	
	Upward	Downward
	From..........to or through..........	From..........to or through..........
Apples	October through February April to May	July through September
Barley	November to December	June to July
Beans, field	None	February to March November to December
Butter	August through October	December through February April through June
Butterfat	August to September November to December	December through February April to May
Calves, veal	December to January June through September	February through May October to November
Cattle	None	October to November
Chickens	December through April	May to June September through November
Corn	June to July	September through December
Eggs	June through November	December through April
Hay, tame	None	June to July
Hogs	December to January June to July	September through December
Lambs	None	July to August September to October
Milk, wholesale	June through November	December through June
Oats	November through January	July to August
Potatoes	March to April June to July	August through October
Rye	November to December	May to June
Sheep	December to January February to March	April through June October to November
Wheat	November through January	February to March
Wool	None	None

monthly movement of prices for a commodity such as wool was not consistently upward or downward for any month over the same period of years. In Table 2 there are seven commodities (barley, field beans, cattle, hay, lambs, rye, and wool) for which the price movements were significant in 2 months or less. For the other 13 commodities, price movements were significant for more than 2 months of the year. For these commodities, it may be profitable in some instances for farmers to change production schedules or time of marketing a month or so with little or no increase in costs, in order to get the higher prices.

Monthly Marketings

Most of the Michigan farm products were moved to market during the months of lowest prices. For example, about one-half of the annual egg production occurred from March through June, four-fifths of the chickens were marketed from July through December, and one-half of the wheat was sold in July, August, and September. In general, most of the cash grains and hay were marketed within a few months following harvest when prices were usually lowest. The bulk of the livestock and livestock products were produced during the seasons when costs of production were lowest. For instance, milk is produced more cheaply in the spring and summer and production is higher then than during the winter. However, one exception to marketing farm products when prices were lowest occurred with cattle. The bulk of the Michigan cattle sales were made up of cull dairy stock and arrived at the market during the time of highest seasonal prices – March through July.

Average Seasonal Movements of Prices, 1910-19

The average seasonal movements of prices in 1910-19 were compared with those in 1933-42 to see whether the pattern of prices changed between the two periods (Table 3). It was found that the

TABLE 3–*Months in which highest and lowest prices occurred for 20 commodities, Michigan, 1910-19**

Commodity	Month of lowest price	Month of highest price	Points—difference low to high
Apples	September	April	47
Barley	October	May	15
Beans, field	December, March**	August	4
Buckwheat	October	June	13
Butter	July	December	24
Calves, veal	May	September***	11
Cattle	December	May	19
Chickens	December	April	20
Corn	February	August	15
Eggs	April	December	53
Hay, tame	August	May	11
Hogs	December	September†	18
Lambs	November	April	19
Milk, wholesale	June	December	42
Oats	October	May	14
Potatoes	November	August	52
Rye	August, September‡	May	8
Sheep	November	April	24
Wheat	August	May	11
Wool	May	July	7

*Seasonal prices were adjusted for price cycles and trends.
**Lowest price averaged the same in December and March.
***Veal calves had a minor peak in January, 1 point below the September peak.
†Hogs had a minor peak in April, 3 points below the September peak.
‡Lowest price averaged the same in August and September.

amount of seasonal variation in 1933-42 as compared with 1910-19 was greater for nine products and less for nine products, while it remained the same for the other two products. The amount of seasonal price variation declined most for milk between the two periods, followed by a smaller decline for butter, cattle, chickens, and sheep (Fig. 3 for milk). The amount of price variation increased most for apples and eggs (Fig. 4 for apples). Perhaps equally important as the change in the amount of variation was the change in the months of peak and low prices. Only five commodities, cattle, chickens, hogs, potatoes, and wheat, had the same months of peak and low prices in both periods.

Changes in the total amount of variation or in the months of peak and low prices were due to several factors. Some of these were: 1) better equipment and production practices, 2) new varieties making for earlier maturity and higher yields, 3) price incentives during low-production months, such as the base-surplus method of buying

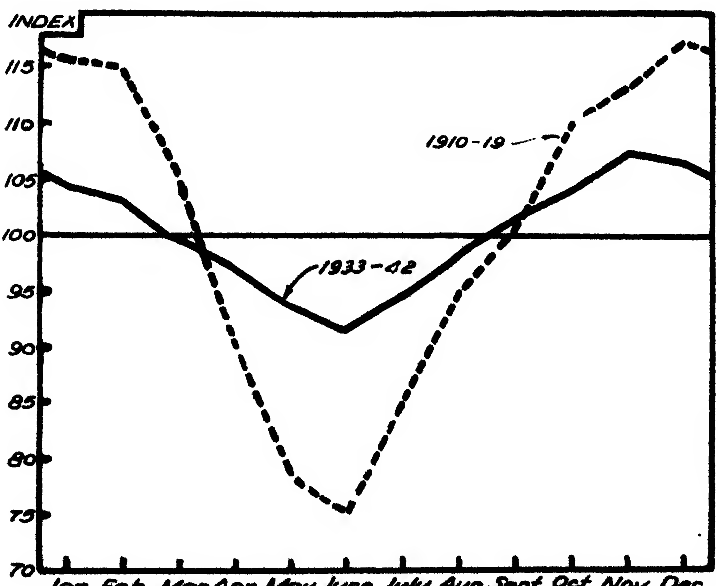

Fig. 3. Milk: indexes of average seasonal variation of Michigan farm prices, 1910-19 and 1933-42.

Between 1910-19 and 1933-42, the amount of seasonal price variation of milk was considerably reduced. This reduction may be attributed to the increase in production in the fall and winter and the relative decrease in production in the spring and summer.

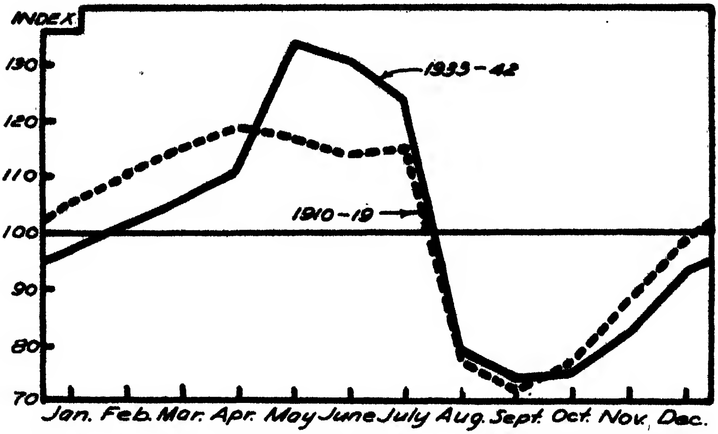

Fig. 4. Apples: indexes of average seasonal variation of Michigan farm prices, 1910-19 and 1933-42.

There was more seasonal variation in apple prices in 1933-42 than in the earlier decade.

milk, and 4) new uses for the product, making for greater consumption. Sometimes, however, the price pattern of one product changes because of a change in the price pattern of another product. For example, the seasonal price pattern for veal calves changed between 1910-19 and 1933-42 because the seasonal price pattern for milk changed. A shift in the time of freshening changes the pattern of milk production. Since the bulk of the veal is marketed from 1 to 2 months following freshening, the price of veal is depressed during these months.

Average Seasonal Price Patterns with Large and Small Crops

The size of the United States crop was a factor affecting the seasonal movement of prices for most of the major crops grown in Michigan. In general, there was about one and one-half times more variation in prices following the harvest of large crops as compared with small crops. The greatest difference between the amount of variation following the harvest of large and small crops was exhibited by potatoes, followed by wheat, hay, and rye (Fig. 5 for potatoes). For these commodities, the price variation following large crops was at least double that following small crops. The amount of seasonal price variation was almost unaffected by the size of crop for apples,

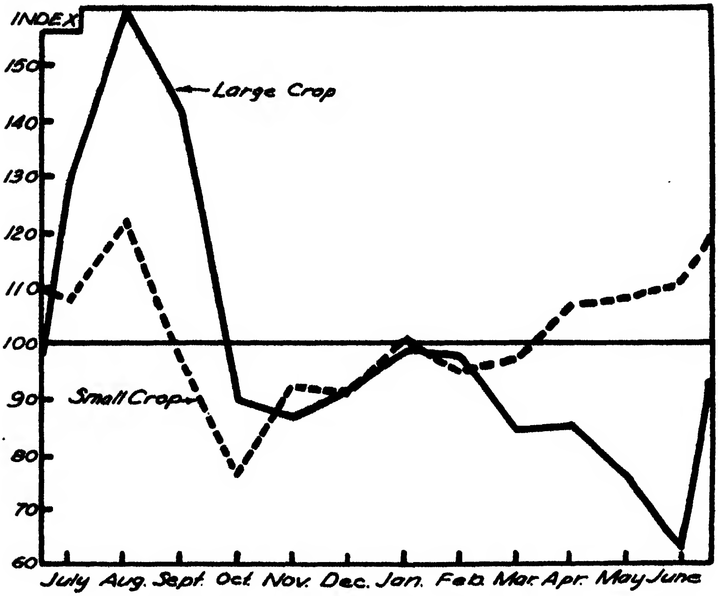

Fig. 5. Potatoes: indexes of average seasonal variation of Michigan farm prices for years following the harvest of two large crops and three small crops selected from the years 1923 to 1942.

There was more than twice as much seasonal variation of potato prices following large crops as compared with small crops.

field beans, and barley (Fig. 6 for barley). For all of the major crops except apples, field beans, and barley, Michigan farmers would have realized greater returns by storing for longer periods following large

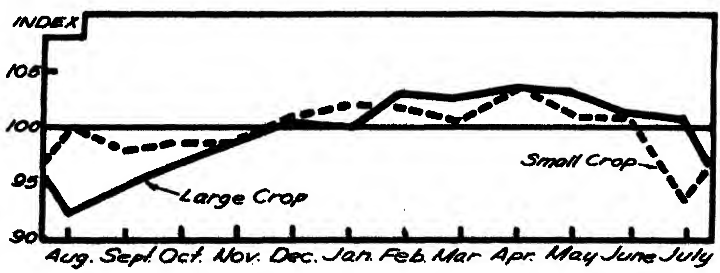

Fig. 6. Barley: indexes of average seasonal variation of Michigan farm prices for years following the harvest of nine large crops and eight small crops selected from the years 1923 to 1942.

There was little difference in the seasonal price pattern of barley with large or small crops.

crops—provided there was little change in the level of all farm prices during the year. For small crops, it was difficult for farmers to make more than costs by storing rather than selling after harvest.

Average Seasonal Price Patterns for Livestock and Livestock Products During Years of Rising or Falling Prices

For livestock and livestock products except eggs, the movement of all farm prices was a potent factor affecting seasonal price patterns. The seasonal movement of egg prices was almost unaffected by the movement of all farm prices (Fig. 7). However, with all the other products, the seasonal price rise was greater (or the seasonal drop was smaller) throughout the year when all farm prices were rising. When farm prices were falling the reverse tended to be true. Wool prices illustrate the difference in patterns with rising or falling prices (Fig. 8). During periods of falling prices, wool prices dropped sharply from January to June, then climbed steadily to December. On the other hand, when all farm prices were rising, wool prices changed little throughout the year.

Shifting production schedules in accordance with price level move-

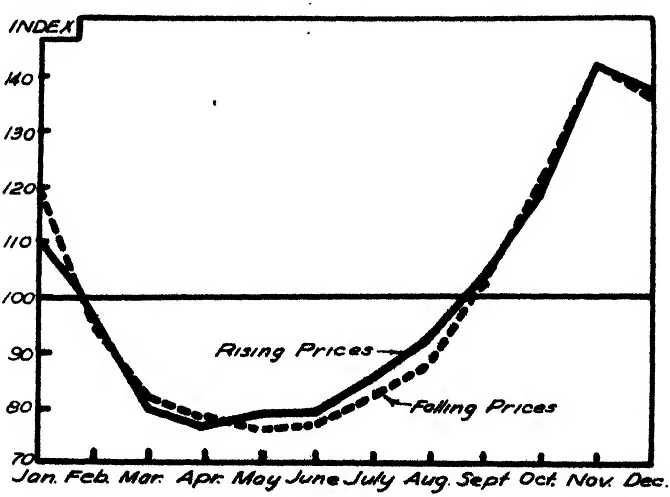

Fig. 7. Eggs: indexes of average seasonal variation of Michigan farm prices for six years of rising prices and five years of falling prices selected from the years 1923 to 1942.

The seasonal movement of egg prices was almost unaffected by rising or falling farm prices.

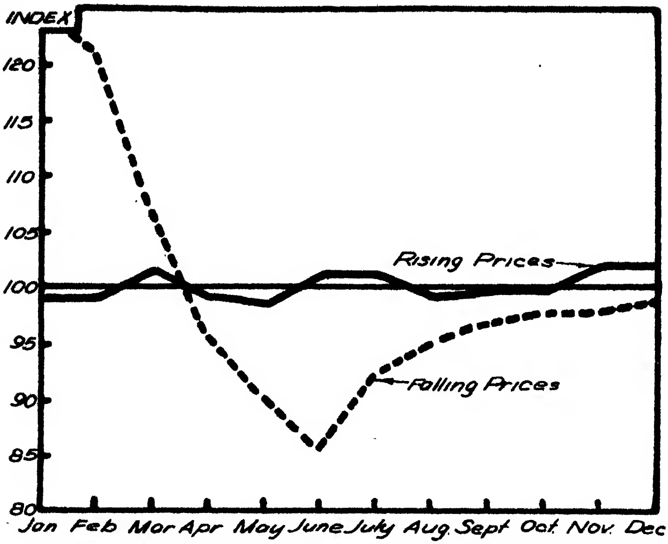

Fig 8. Wool: indexes of average seasonal variation of Michigan farm prices for six years of rising and five years of falling prices selected from the years 1923-42.

During periods of rising prices, wool prices held about steady throughout the year. However, there was a large amount of seasonal price variation during years of falling prices.

ments appears profitable during prolonged periods of rising or falling farm prices. Marketing later in years of rising farm prices and earlier in years of falling farm prices seems advisable.

Effect of Rising or Falling Farm Prices on the Seasonal Price Patterns of the Major Crops

Almost without exception, it paid Michigan farmers to store the major crops in years of rising farm prices. When these years were combined with years of large crops, it became exceptionally profitable to store. During periods of falling farm prices, it paid to move as much of the crop as possible soon after harvest. This was especially true following the harvest of a small crop. A problem arose as to the time to market in those years when the crop was short and prices were rising as well as in those years when production was high and prices were falling. No general rule may be applied in these cases since the forces tend to move prices in opposite directions from the average

adjusted seasonal pattern. The problems merely resolve themselves to questions of degree. That is, how short is the crop and how much will prices rise, or how large is the crop and how much will prices fall?

Summary and Conclusions

The amount of seasonal variation in the prices of the major Michigan farm products was closely related to the perishability of the commodity. More perishable products such as eggs, apples, and potatoes had a large amount of seasonal price variation. Crops such as corn, wheat, oats, barley, rye, field beans, and hay had a smaller amount of seasonal price variation because they could be relatively easily and inexpensively stored. The price rise throughout the year for the major crops represented about what it cost to store from one harvest to the next.

The amount of seasonal variation, as well as the months of high and low prices, changed for most products between 1910-19 and 1933-42. For the most part, these changes could be attributed to technological advances as they affected the volume of production and efficiency, or to changes in consumption habits as they affected the seasonal demand for the products.

The size of the United States crop was a factor affecting seasonal price changes of the major crops produced in Michigan. There was less variation in years following the harvest of small crops as compared with years following the harvest of large crops. Farmers who had the alternative of storing or selling at harvest time usually gained more by storing a large crop rather than a small one.

A major movement of all farm prices was an important factor affecting seasonal price movements. In general, when all farm prices were rising the seasonal price rise was greater, or the seasonal drop was smaller than usual for individual products. The reverse tended to be true when the trend of all farm prices was downward. Thus, marketing later in years of rising prices, and earlier in years of falling prices paid farmers greater dividends.

It is not always advisable for farmers to change production methods or storage practices to get the highest price. Shifts of this sort may be too costly to be profitable. Also, before average seasonal price figures that have been adjusted for trend are applied in any year, allowances for probable future price trends, crop prospects, and the like should be made.

POPULATION CHANGE IN THE RURAL AND URBAN AREAS OF MICHIGAN SINCE 1940

By J. F. THADEN
SECTION OF SOCIOLOGY AND ANTHROPOLOGY

THERE is no question but that the population of Michigan has increased considerably since 1940. The last complete enumeration was that of 1940, made by the United States Bureau of the Census. However, this agency has made estimates of population of this and the other states from time to time. It estimates the population of Michigan to be 6,069,000 as of July 1, 1947, an increase of 812,894, or 15.5 percent over the population figure of 5,256,106 on April 1, 1940. This estimated increase is the same as in Connecticut but greater than that in the other states excepting Maryland, Florida, Arizona, Utah, Nevada, Washington, Oregon, California, and the District of Columbia.[1]

On January 28, 1947, the Bureau made a special census of Oakland County, which shows that its population increased from 254,068 in 1940 to 336,469 in 1947, an increase of 32.4 percent.[2] Population figures are also available for each of the minor civil divisions of this county. They show that, as a rule, the population of the townships lying close to Detroit and to the larger urban centers, like Pontiac and Royal Oak, increased much more than those lying at greater distances. Much of this county lies in what may be called the suburban "fringe" of Detroit, and, like most "fringe" areas, is increasing in population at a phenomenal rate.

Since 1940, the Bureau has also made other special enumerations in Michigan, including Muskegon County (June 1944), the townships of Ecorse, Gratiot, Romulus, Taylor and Van Buren in Wayne County, Shelby Township in Oceana County and the cities and villages of Adrian, Brighton, Chelsea, Essexville, Inkster, Prescott and Rogers City.

[1]U. S. Bureau of the Census, Current Population Reports, Population Estimates, Series P-25, No. 12, August 9, 1948.

[2]U. S. Bureau of the Census, Current Population Reports, Special Censuses, Series P-28, No. 234.

ARTICLE 31-26

We commonly make comparisons between counties and community centers with respect to such factors as ratio of population per physician, per hospital bed, per library, or the percentage of people on relief, unemployed, or seeking old-age pensions, on the basis of the last population census, in recent years that of 1940. Such comparisons are valid only when population changes in the units that are compared have been similar. To compare two counties with respect to such factors as are mentioned above, on the basis of their 1940 populations, in one of which the population has since increased 30 percent or more and in the other it has decreased 15 percent or more, would be misleading. Many social and economic research studies and action programs are dependent upon population and its mobility and composition. Almost everyone is interested to some extent in population changes in his village, city, community and county because every social institution and organization is affected thereby. The expansion of such services as telephone lines, roads, school buildings, gas and water mains, and sewage disposal plants is closely related to population change. This article attempts to indicate the population change since 1940 by counties, and by rural and urban areas of Michigan, and second, to account for the change by natural increase (excess of births over deaths) and by migration.

The 1950 census is only 18 months away and the population figures for all cities, villages, townships and counties of Michigan will be available late in 1950. Until that time such research studies as are dependent upon population figures must rely considerably on estimates of population. The annual school census may be considered first as a means of making such estimates.

THE SCHOOL CENSUS AS A SOURCE OF POPULATION ESTIMATES

Children of school age, in Michigan those from 5-19 inclusive, are a considerable proportion of the total population. In this state they comprised 25.9 percent of the total population in 1940. The percentage varied from 21.51 in Washtenaw County to 33.35 percent in Presque Isle County.

The range is even greater for the urban centers, varying from 18.8 in Ann Arbor to 37.8 in Kingsford. There are also wide ranges in the subdivisions of the rural populations, varying in the rural-farm population from 25.9 in Branch County to 36.0 percent in Mackinac

County, and in the rural non-farm population from 19.9 in Luce County to 32.4 percent in Dickinson County.

In Michigan, the census of school-age children is taken annually during the last 20 days of May, by school census enumerators, in each school district, of which there are still over 5,000. This annual census is quite complete and accurate, since approximately 15 to 20 million dollars of state aid has been distributed to school districts annually in recent years on the basis of the number of children. It is probably more complete than that taken by the United States Bureau of the Census. In 1940, the former enumerated 1,385,576 persons, while the latter counted only 1,360,992. Part of the difference of 24,584 may be accounted for by migration into Michigan from other states between April 1, 1940 and the last of May of that same year. Annually at this season of the year the orchards and fields of Michigan become meccas for many agricultural migrants and their families.

Trends in the school census population generally give clues to the trend of the population, and the extent of population change. For example, in Dickinson County, school-age children have dwindled annually since 1940, dropping from 9,095 in 1940 to 6,738 in 1947, a decrease of 25.9 percent. On the other hand, school-age children increased annually in Macomb County during the same period, from 32,940 in 1940 to 43,067 in 1947, an increase of 30.7 percent. Presumably, there was a substantial drop in the total population since 1940 in Dickinson County and a very material increase in Macomb County. However, the changes in total population in these counties were not necessarily in direct proportion to the change in school-age population. The reason for this is that during the greater part of the past two decades birth rates have been falling rapidly so that children of school-age during this period were a constantly decreasing proportion of the total population. To illustrate, from 1930 to 1940, the total population in Michigan increased 8.5 percent, while the children in the age-group 5-19 increased only from 1,359,325 to 1,360,992, or one-tenth of 1 percent.

School-age children in Michigan comprised 28.07 percent of the total population in 1930 and only 25.89 percent in 1940. The percentage was less in 1940 than in 1930 in 81 of the 83 counties. In the two counties, which were exceptions in this respect, the increase was slight, less than 1 percent in Calhoun County and one-fourth of 1 percent in Genesee County.

Unquestionably the trend that prevailed during the 'thirties in the ratio of school census population to total population has continued since 1940. For the United States as a whole, children 5-19 years old comprised 26.30 percent of the total population in 1940, and the United States Bureau of the Census estimates that they comprised 23.89 percent in 1946[3]. In Oakland County, Michigan, children in the age-group 5-19 comprised 27.54 percent of the total population in 1940 and only 24.95 percent on January 28, 1947.

According to the annual reports of the State Superintendent of Public Instruction in Michigan, 32 counties had more school-age children in 1947 than during any of the preceding 7 years and six counties had fewer children annually in this age group. In the 15 upper peninsula counties, the number of school-age children decreased from 94,267 in 1940 to 80,458 in 1947, a decrease of 14.7 percent. The school-age population decreased in 19 counties north of the Bay City-Muskegon line, which amounted to 5.2 percent during the 1940-47 period. In the four southern tiers of counties and in Muskegon, Saginaw, Bay and Midland counties the school-age population increased 4.2 percent. These figures on the change in school-age population roughly indicate the change in total population. When allowance is made for the changing ratio of school-age population to the total population, the resulting estimated population should approximate rather closely in most instances the actual population.

A brief review of the changing ratio of school-age population between 1930 and 1940 seems desirable as a basis of computing estimated population since 1940. During the decade of the 'thirties the percentage of school-age children in the total population decreased most in those counties where they comprised a relatively large proportion in 1930. For example, in Gogebic County children of the ages 5-19 comprised 35.3 percent of the total population in 1930, but decreased to 28.0 percent by 1940, or 7.3 percentage points. On the other hand, in Calhoun County the percentages at the same respective dates were 25.0 and 24.0. In the 17 counties in which they comprised less than 28 percent of the total population in 1930 the decreases averaged 1.63 percent; in the 47 counties in which they comprised 28 to 33 percent, the decreases averaged 2.83 percent; and in the 17 counties in which they comprised 34 percent or more the decreases averaged 5.72 percent. As noted earlier, there were very slight increases in two counties.

[3] U. S. Bureau of the Census, Population, Special Reports, Series P-47, No. 3, April 3, 1947.

Between 1940 and 1947 the number of school-age children in Michigan remained quite constant, the extremes being 1,382,979 in 1941 and 1,414,497 in 1947. The latter figure is 23.3 percent of the total estimated population of 6,069,000 for 1947, a substantial drop from the 25.9 percent of 1940.

The procedure followed in making estimates of population of counties for 1947, based on the school censuses of 1940 and 1947, was as follows: It was assumed that the school-age population in each county would be less in 1947 than in 1940, the amount varying from county to county, ranging from 0.65 to 3.6, being greater for counties in which that age group still comprised a relatively large percentage of the total population in 1940. It was assumed that in any county in which the school-age population comprised 21.5 percent of the total population in 1940, as in Washtenaw County, that by 1947 the age group would comprise only 20.85 percent, (21.5 less 0.65 = 20.85). It was also assumed that in the county at the other extreme, namely Presque Isle, in which the school-age children comprised 30.3 percent of the total population in 1940, that the percentage had dropped only to 26.7 (30.3 less 3.6 = 26.7) by 1947. It was assumed further that the percentage of change in the other counties would lie in between these two extremes, and that with each increase of 0.10 in the percentage that school-age children are of total population in 1940 the amount they comprised of the total population in 1947 would have dropped 0.025. To illustrate, in Bay County in 1940, school-age children comprised 27.26 percent of the total population. Therefore, according to the above-mentioned sliding or graduated scale, it was assumed that they comprised 25.175 percent of the total population in 1947. The school census for this county in 1947 was 21,959 which results in an estimated total population of 87,243. This figure tallies closely with the figure of 87,389, the estimated population as determined by the Michigan Department of Health, using a method to be discussed later.

The estimated population of counties obtained by this method are within 1 percent of the estimated population as computed by the Michigan Department of Health for the counties of Bay, Branch, Cass, Keweenaw, Osceola, St. Joseph, and Shiawassee, and between 1 and 5 percent for the counties of Alger, Alpena, Berrien, Dickinson, Eaton, Genesee, Gogebic, Grand Traverse, Gratiot, Hillsdale, Houghton, Ionia, Isabella, Kent, Lenawee, Luce, Marquette, Mason, Midland, Monroe, Montcalm, Oceana, Ottawa, St. Clair, Tuscola, and Van Buren. Differences between the two estimates were greater than 20 percent for

the counties of Crawford and Mackinac, and between 15 and 20 percent for the six counties of Delta, Kalkaska, Lake, Montmorency, Ogemaw, and Washtenaw. With the exception of Washtenaw County, these eight counties have a relatively sparse population. Willow Run, between Ann Arbor and Ypsilanti, in Washtenaw County was created during the war and became an important army plane manufacturing center, which attracted many thousand persons from other states.

Although school-age children comprise a rather large percentage of the total population, varying for the different counties from 21.5 to 30.3 in 1940, and presumably from 20.85 to 26.7 in 1947, population estimates of counties, and of cities and rural areas of counties are probably more accurately determined now by a formula recently devised by Hope Tisdale Eldridge of the Population Division of the United States Bureau of the Census.[4] This is the formula used by the Bureau of Records and Statistics of the Michigan Department of Health in arriving at its estimates of population for 1947.

TOTAL POPULATION, 1940 AND 1947

The Bureau of Records and Statistics of the Michigan Department of Health finds it necessary to make current population estimates of counties and of urban centers and rural areas in order to compute birth rates and death rates that are more accurate than such rates would be if they were based on the population figures of the last census. To compute such current rates on the basis of the 1940 population figures would be meaningless for localities in which the population had either increased or decreased considerably since the last census date. The Michigan Department of Health utilizes the population estimates of the United States Bureau of the Census and its formula for determining the population of subdivisions of the state. The population estimates for 1947 that have been computed by this State Bureau are based on "Suggested Procedures for Estimating the Current Population of Counties", by the United States Bureau of the Census[5] and on the excess of births over deaths between April 1, 1940 and July 1, 1947. These population estimates seem to be reasonably satisfactory and in most instances tend to correspond quite closely with population estimates that might be derived from the school population censuses of 1940 and 1947 when due allowances are made for the decreasing proportion that children of school age are of the total population. The method takes

[4] U. S. Bureau of the Census, Population, Special Reports, Series P-47, No. 4, April 30, 1947.
[5] U. S. Bureau of the Census, Population-Special Reports, Series P-47, No. 4, April 30, 1947.

TABLE 1—*Population of Michigan counties, April 1, 1940 and July 1, 1947, and population change*

County	April 1, 1940*	July 1, 1947**	Change	
			Number	Percent
Alcona***	5,463	4,558	− 905	−16.6
Alger	10,167	9,864	− 303	− 3.0
Allegan	41,839	43,873	2,034	4.9
Alpena	20,766	21,804	1,038	5.0
Antrim***	10,964	10,601	− 363	− 3.3
Arenac***	9,233	9,282	49	.5
Baraga	9,356	8,427	− 929	− 9.9
Barry	22,613	25,946	3,333	14.7
Bay	74,981	87,389	12,408	16.5
Benzie***	7,800	7,842	42	.5
Berrien	89,117	112,485	23,368	26.2
Branch	25,845	28,978	3,133	12.1
Calhoun	94,206	112,243	18,037	19.1
Cass	21,910	26,145	4,235	19.3
Charlevoix	13,031	13,792	761	5.8
Cheboygan	13,644	13,607	− 37	− .3
Chippewa	27,807	29,912	2,105	7.6
Clare***	9,163	10,219	1,056	11.5
Clinton	26,671	32,269	5,598	21.0
Crawford***	3,765	3,374	− 391	−10.4
Delta	37,037	31,772	−5,265	−14.2
Dickinson	28,731	23,368	−5,363	−18.7
Eaton	34,124	37,512	3,388	9.9
Emmet	15,791	15,287	− 504	− 3.2
Genesee	227,944	254,710	26,766	11.7
Gladwin***	9,385	10,095	710	7.6
Gogebic	31,797	25,791	−6,006	−18.9
Grand Traverse	23,390	28,027	4,637	19.8
Gratiot	32,205	34,761	2,556	7.9
Hillsdale	29,092	33,510	4,418	15.2
Houghton	47,631	39,153	−8,478	−17.8
Huron	32,584	32,647	63	.2
Ingham	130,616	152,918	22,302	17.1
Ionia	35,710	38,686	2,976	8.3
Iosco***	8,560	11,010	2,450	28.6
Iron	20,243	16,633	−3,610	−17.8
Isabella	25,982	26,748	766	2.9
Jackson	93,108	107,726	14,618	15.7
Kalamazoo	100,085	116,569	16,484	16.5
Kalkaska***	5,159	4,371	− 788	−15.3
Kent	246,338	259,478	13,140	5.3
Keweenaw***	4,004	3,299	− 705	−17.6
Lake***	4,798	4,863	65	1.4
Lapeer	32,116	33,941	1,825	5.7
Leelanau***	8,436	7,811	− 625	− 7.4
Lenawee	53,110	63,104	9,994	18.8
Livingston	20,863	23,640	2,777	13.3
Luce	7,423	8,522	1,099	14.8
Mackinac	9,438	7,659	−1,779	−18.8
Macomb	107,638	168,528	60,890	56.6
Manistee	18,450	17,380	−1,070	− 5.8
Marquette	47,144	45,204	−1,940	− 4.1
Mason	19,378	18,529	− 849	− 4.4
Mecosta	16,902	16,827	− 75	− .4
Menominee	24,883	22,336	−2,547	−10.2
Midland	27,094	36,039	8,945	33.0
Missaukee***	8,034	7,688	− 346	− 4.3
Monroe	58,620	68,933	10,313	17.6
Montcalm	28,581	30,888	2,307	8.1
Montmorency***	3,840	3,906	66	1.7
Muskegon	94,501	130,386	35,885	38.0
Newaygo	19,286	20,431	1,145	5.9
Oakland	254,068	336,469	82,401	32.4
Oceana***	14,812	15,618	806	5.4
Ogemaw***	8,720	8,480	− 240	− 2.8

TABLE 1—*Continued*

County	April 1, 1940*	July 1, 1947**	Change	
			Number	Percent
Ontonagon***	11,359	10,771	– 588	– 5.2
Osceola***	13,309	14,500	1,191	8.9
Oscoda***	2,543	3,186	643	25.3
Otsego***	5,827	6,045	218	3.7
Ottawa	59,660	69,408	9,748	16.3
Presque Isle	12,250	11,540	– 710	– 5.8
Roscommon***	3,668	6,220	2,552	69.6
Saginaw	130,468	154,952	24,484	18.8
Sanilac***	30,114	29,775	– 339	– 1.1
Schoolcraft	9,524	9,412	– 112	– 1.2
Shiawassee	41,207	43,883	2,676	6.5
St. Clair	76,222	89,564	13,342	17.5
St. Joseph	31,749	33,793	2,044	6.4
Tuscola	35,694	39,111	3,417	9.6
Van Buren	35,111	37,879	2,768	7.9
Washtenaw	80,810	115,006	34,196	42.3
Wayne	2,015,623	2,361,974	346,351	17.2
Wexford	17,976	18,118	142	.8
Michigan	5,256,106	6,069,000	812,894	15.5

*United States Bureau of the Census.
**Estimates made by the Bureau of Records and Statistics, Michigan Department of Health.
***County has no urban population.

into consideration ten factors or variables and estimates based thereon are likely to be more trustworthy than estimates based on the school census only. It is used, therefore, in this analysis of population change and the contribution of natural increase and of migration to the change.

Table 1 gives the population of counties of Michigan in 1940 as enumerated by the United States Bureau of the Census as of April 1, 1940 and the estimated population as of July 1, 1947 as determined by the Bureau of Records and Statistics of the Michigan Department of Health. This table indicates that the population increased in 56 counties, in which 30 of them the increase was 10 percent or more. The counties with the greatest percentage increase are Roscommon, Macomb, Washtenaw, Muskegon, Midland, Oakland, Iosco, Berrien, and Oscoda, ranging from 25.3 to 69.6 percent. The absolute increase was greatest in Wayne County, a total of 346, 351, followed by Oakland County with 82,401 and Macomb County with 60,890. Population increases in general have been greatest in industrial areas and in suburban regions of the larger urban centers.

In 27 counties the population seems to have decreased between 1940 and 1947. This decrease in most of these counties may be attributed in part to decrease in farm population, since in 23 of them

there were fewer persons in 1945 than in 1940. However, there were also decreases in the number of farms between these dates in 43 other counties. In 10 counties population decrease amounted to 10 percent or more. The largest percentage decreases are in Gogebic, Mackinac, Dickinson, Houghton, Iron, and Keweenaw counties, ranging from 17.6 to 18.9 percent. The absolute decrease was greatest in Houghton County, a total of 8,478, followed by Gogebic County with 6,006. All 15 counties in the upper peninsula, except Chippewa and Luce, seem to have less population at present, than in 1940. None of the 35 counties in the five southern tiers of counties, lost population during the past 7 years, except Sanilac, in which the decrease was slight, 1.1 percent.

The population decline in some of the upper peninsula counties has been operative for many years. For example, in Houghton County, the population reached a peak of 88,098 in 1910, dropped to 71,930 in 1920, to 52,851 in 1930, 47,631 in 1940, and presumably to 39,153 in 1947. The closing of copper mines is the principal contributing factor in this formerly very important mining county. The population decline has also been fairly constant in Keweenaw County since 1910, in Iron and Schoolcraft counties since 1920, and in Delta and Dickinson counties since 1930. Diminished lumbering activities have been important contributing factors in recent decades in these northern counties.

Increased population necessitates increased services and facilities such as schools, teachers, doctors, dentists, shops, and stores, while a slump in population reduces such needs. In general, mobility of population tends to reflect changing economic conditions and opportunities. These can fluctuate considerably in an industrial civilization and in a diversified industrial-agricultural state like Michigan.

COMPARISON OF POPULATION TRENDS IN RURAL AND URBAN AREAS

For the state as a whole, the population increase since 1940 was greater in the urban centers than in the rural areas. The population in the rural areas increased from 1,801,239 in 1940 to 2,056,008 in 1947, an increase of 254,769, or 14.1 percent, while that in the urban centers increased from 3,454,867 to 4,012,992, an increase of 558,125, or 16.2 percent. These numbers reflect the tremendous activity in the automobile industry and its allied fields in this state.

There are 22 counties that are entirely rural, that is, have no cities

TABLE 2—*Rural and urban populations of counties of Michigan in April 1, 1940, and July 1, 1947, and percentage change*

County	Rural population			Urban population		
	April 1, 1940*	July 1, 1947**	Percentage change	April 1, 1940*	July 1, 1947**	Percentage change
Alger	5,758	5,514	− 4.2	4,409	4,350	− 1.3
Allegan	33,885	35,434	4.6	7,954	8,439	6.1
Alpena	7,958	8,392	5.5	12,808	13,412	4.7
Baraga	6,792	6,042	−11.0	2,564	2,385	− 7.0
Barry	17,438	19,991	14.6	5,175	5,955	15.1
Bay	27,025	31,545	16.7	47,956	55,844	16.4
Berrien	48,102	59,483	23.7	41,015	53,002	29.2
Branch	18,502	20,623	11.5	7,343	8,355	13.8
Calhoun	37,155	44,343	19.3	57,051	67,900	19.0
Cass	16,903	19,913	17.8	5,007	6,232	24.5
Charlevoix	10,127	10,705	5.7	2,904	3,087	6.3
Cheboygan	7,971	7,943	− .4	5,673	5,664	− .2
Chippewa	11,960	12,620	5.5	15,847	17,292	9.1
Clinton	22,249	27,038	21.5	4,422	5,231	18.3
Delta	14,235	13,366	− 6.1	19,802	18,406	− 7.0
Dickinson	8,152	6,500	−20.3	20,579	16,868	−18.0
Eaton	21,621	23,761	9.9	12,503	13,751	10.0
Emmet	9,772	9,486	− 2.9	6,019	5,801	− 3.6
Genesee	73,024	83,161	13.9	154,920	171,549	10.7
Gogebic	10,757	8,649	−19.6	22,040	17,142	−22.2
Grand Traverse	8,935	10,841	21.3	14,455	17,186	18.9
Gratiot	21,964	23,567	7.3	10,241	11,194	9.3
Hillsdale	22,711	26,080	14.8	6,381	7,430	16.4
Houghton	34,455	28,213	−18.1	13,176	10,940	−17.0
Huron	29,960	29,956	.0	2,624	2,691	2.6
Ingham	43,157	57,821	34.0	87,459	95,097	8.7
Ionia	25,229	27,275	8.1	10,481	11,411	8.9
Iron	13,186	10,850	−17.7	7,057	5,783	−18.1
Isabella	17,569	18,016	2.5	8,413	8,732	3.8
Jackson	43,452	49,142	13.1	49,656	58,584	18.0
Kalamazoo	45,988	51,484	12.0	54,097	65,085	20.3
Kent	77,147	82,141	6.5	169,191	177,337	4.8
Lapeer	26,751	28,179	5.3	5,365	5,762	7.4
Lenawee	35,959	42,384	17.9	17,151	20,720	20.8
Livingston	17,115	19,288	12.7	3,748	4,352	16.1
Luce	4,691	5,127	9.3	2,732	3,395	24.3
Mackinac	6,769	5,410	−20.1	2,669	2,249	−15.7
Macomb	53,412	89,915	68.3	48,226	78,613	63.0
Manistee	9,756	9,106	− 6.7	8,694	8,274	− 4.8
Marquette	14,912	14,330	− 3.9	30,232	30,874	2.1
Mason	10,677	10,072	− 5.7	8,701	8,457	− 2.8
Mecosta	11,915	11,840	− .6	4,987	4,987	.0
Menominee	14,653	12,868	−12.2	10,230	9,468	− 7.4
Midland	16,765	21,767	29.8	10,329	14,272	38.2
Monroe	40,142	45,867	14.3	18,478	23,066	24.8
Montcalm	23,260	25,028	7.6	5,321	5,860	10.1
Muskegon	30,757	43,617	41.8	63,744	86,769	36.1
Newaygo	16,766	17,706	5.6	2,520	2,725	8.1
Oakland	110,962	162,749	46.7	142,994	173,720	21.5
Ottawa	33,238	38,838	16.8	26,422	30,570	15.7
Presque Isle	9,178	8,506	− 7.3	3,072	3,034	− 1.2
Saginaw	47,674	57,186	20.0	82,794	97,766	18.1
Schoolcraft	4,125	4,131	.1	5,399	5,281	− 2.2
Shiawassee	23,656	25,066	6.0	17,551	18,817	7.2
St. Clair	36,359	42,205	16.1	39,863	47,359	18.8
St. Joseph	17,825	19,101	7.2	13,924	14,692	5.5
Tuscola	32,624	35,773	9.7	3,070	3,338	8.7
Van Buren	30,366	32,672	7.6	4,745	5,207	9.7
Washtenaw	38,874	54,349	39.8	41,936	60,657	44.6
Wayne	85,842	101,536	18.3	1,929,888	2,260,438	17.1
Wexford	8,121	7,983	− 1.7	9,855	10,135	2.8

*United States Bureau of the Census.
**Estimates made by the Bureau of Records and Statistics, Michigan Department of Health.

or villages of 2,500 or more inhabitants. These counties are indicated (***) in Table 1. In 12 of them, Arenac, Benzie, Clare, Gladwin, Iosco, Lake, Montmorency, Oceana, Osceola, Oscoda, Otsego, and Roscommon, the population increased during the past 7 years. The increase was only 0.5 percent in Arenac and Benzie counties and as much as 69.6 in Roscommon. The increase of 2,552 in Roscommon County took place largely around Higgins and Houghton lakes and in and near the unincorporated villages of Prudenville, Houghton Lake, The Heights, and the incorporated village of Roscommon. The increase of 2,450, or 28.6 percent, in Iosco County is concentrated largely in and near the incorporated cities of East Tawas and Tawas City. The increase of 643, or 25.3 percent in Oscoda County is centered primarily in and near the unincorporated village of Oscoda, near which was a large army air base during the war.

The population apparently decreased since 1940 in the other 10 entirely rural counties, namely, Alcona, Antrim, Crawford, Kalkaska, Keweenaw, Leelanau, Missaukee, Ogemaw, Ontonagon, and Sanilac. The decrease varied from 1.1 percent in Sanilac County to 17.6 in Keweenaw County. There were fewer farms in 10 of these 12 counties in 1945 than in 1940, in all except Alcona and Ogemaw, so that part of the population decrease may be attributed to this cause.

There are 61 counties which have one or more urban centers, that is, they have one or more incorporated cities or villages or both, which have 2,500 or more inhabitants, and therefore these counties have both rural and urban populations. These 61 counties are listed in Table 2, with their rural and urban populations for 1940 and 1947 and percentage change.

As a rule, urban and rural population increases or decreases were simultaneous and similar within counties, which reflect considerable degree of interdependence. The increase in population was greater in the rural areas than in the urban centers in 16 of the counties, which have both rural and urban populations. Most of these counties are those with the largest cities of the state, such as Wayne, Genesee, Kent, Saginaw, Ingham, Bay, Calhoun, Muskegon, and Oakland. This reflects the phenomenal expansion of population in localities that are suburban to the metropolitan centers and the medium-sized cities. Industrial workers make their living in the cities but there seems to be an increasing tendency for them to seek the country as a place to live.

In Kalamazoo and Jackson counties, and in 25 other counties the increase in population was greater in the urban centers than in the

rural areas from 1940 to 1947. As a rule, the difference was not considerable in these 43 counties. In Eaton County, the difference was less than one-tenth of 1 percent.

The decrease in population was greater in the rural areas than in the urban centers in 9 counties, while it was greater in the urban centers than in the rural areas of Baraga, Delta, Emmet, Gogebic, and Iron counties. In most instances the difference was rather slight.

In Marquette and Wexford counties the population decreased in the rural areas but increased in the urban centers, while the reverse situation prevailed in Schoolcraft County. However, the increase in Schoolcraft County was only one-tenth of 1 percent. The foregoing figures of population change indicate the simultaneous responsiveness of both rural and urban peoples within counties to changing economic conditions and opportunities.

Among the more populous counties the greatest percentage difference in the change in rural and urban populations since 1940 occurred in Ingham and Oakland counties. In Ingham County the rural population increased 34 percent and the urban population increased 8.7 percent. In Oakland County the rural population increased 46.7 percent and in its eight urban centers the increase averaged 21.5 percent from 1940 to 1947.

The school census in several school districts around Lansing showed increases as follows: from 294 to 455; from 175 to 253; from 117 to 195; from 113 to 159; from 62 to 135; and from 58 to 91. In Oakland County, the school census from 1940 to 1947 revealed increases in several school districts as follows: from 2,102 to 3,746; from 254 to 419; from 146 to 231; and from 93 to 241. These figures indicate, among other things, the additional school building problems created by changes in school-age population in several suburban areas.

CONTRIBUTION OF NATURAL INCREASE AND MIGRATION TO POPULATION CHANGE FROM 1940 TO 1947

Natural increase, excess of births over deaths, contributed somewhat more to the population growth of Michigan since 1940 than net migration from other states and from foreign countries. Births during this period totaled 874,442 and deaths totaled 391,693, resulting in a natural increase of 482,749[6]. This latter figure, when deducted from the

[6]Three-fourths of the births and deaths of 1940 and one-half of those occurring in 1947 were used in these computations, in order to correspond with April 1, 1940 and July 1, 1947.

TABLE 3—*Population change, natural increase, and net migration, by counties from April 1, 1940 to July 1, 1947*

County	Population change, 1940-47	Natural increase 1940-47	Net migration, 1940-47	County	Population change, 1940-47	Natural increase 1940-47	Net migration, 1940-47
Alcona	−905	364	−1,269	Lenawee	9,994	4,073	5,921
Alger	−303	876	−1,179	Livingston	2,777	1,207	1,570
Allegan	2,034	2,564	− 530	Luce	1,099	517	582
Alpena	1,038	1,960	− 922	Mackinac	−1,779	683	−2,462
Antrim	−363	587	− 950	Macomb	60,890	16,199	44,691
Arenac	49	535	− 486	Manistee	−1,070	844	−1,914
Baraga	− 929	500	−1,429	Marquette	−1,940	3,193	−5,133
Barry	3,333	1,071	2,262	Mason	− 849	1,093	−1,942
Bay	12,408	7,841	4,567	Mecosta	− 75	1,040	−1,115
Benzie	42	387	− 345	Menominee	−2,547	2,194	−4,741
Berrien	23,368	7,214	16,154	Midland	8,945	4,476	4,469
Branch	3,133	1,161	1,972	Missaukee	− 346	686	−1,032
Calhoun	18,037	7,778	10,259	Monroe	10,313	4,869	5,444
Cass	4,235	582	3,653	Montcalm	2,307	1,522	785
Charlevoix	761	789	− 28	Montmorency	66	314	− 248
Cheboygan	− 37	915	− 952	Muskegon	35,885	12,496	23,389
Chippewa	2,105	2,894	− 789	Newaygo	1,145	1,300	− 155
Clare	1,056	708	348	Oakland	82,401	34,678	47,723
Clinton	5,598	2,126	3,472	Oceana	806	759	47
Crawford	− 391	149	− 540	Ogemaw	− 240	654	− 894
Delta	−2,265	2,221	−4,486	Ontonagon	− 588	470	−1,058
Dickinson	−5,363	2,022	−7,385	Osceola	1,191	929	262
Eaton	3,388	2,293	1,095	Oscoda	643	203	440
Emmet	− 504	1,134	−1,638	Otsego	218	406	− 188
Genesee	26,766	25,537	1,229	Ottawa	9,748	6,208	3,540
Gladwin	710	879	− 169	Presque Isle	− 710	1,219	−1,929
Gogebic	−6,006	2,036	−8,042	Roscommon	2,552	258	2,294
Grand Traverse	4,637	1,796	2,841	Saginaw	24,484	12,875	11,609
Gratiot	2,556	2,773	− 217	Sanilac	− 339	1,808	−2,147
Hillsdale	4,418	1,583	2,835	Schoolcraft	− 112	824	− 936
Houghton	−8,478	1,402	−9,880	Shiawassee	2,676	3,202	− 526
Huron	63	2,710	−2,647	St. Clair	13,342	6,065	7,277
Ingham	22,302	14,612	7,690	St. Joseph	2,044	2,264	− 220
Ionia	2,976	2,248	728	Tuscola	3,417	2,583	834
Iosco	2,450	641	1,809	Van Buren	2,768	1,125	1,643
Iron	−3,610	1,269	−4,879	Washtenaw	34,196	9,556	24,640
Isabella	766	2,430	−1,664	Wayne	346,351	191,819	154,532
Jackson	14,618	6,777	7,841	Wexford	142	1,209	−1,067
Kalamazoo	16,484	8,856	7,628				
Kalkaska	− 788	332	−1,120				
Kent	13,140	19,910	−6,770	Michigan	812,894	482,749	330,145
Keweenaw	− 705	37	− 742				
Lake	65	88	− 23				
Lapeer	1,825	1,896	− 71				
Leelanau	− 625	446	−1,071				

total population increase from 1940 to 1947, represents net migration into Michigan, which amounted to 330,145 during the 7.25-year period. Thus, natural increase contributed 59 percent to the growth of the population of Michigan and migration from other states and countries contributed 41 percent.

The two basic factors which affect population numerically in any locality are migration and the genetic elements of births and deaths. Table 3 shows the numerical increase or decrease in population of the counties between April 1, 1940 and July 1, 1947, and the amount of this

population change contributed by excess of births over deaths and the amount that was the result of migration. It will be noted, for example, that of the increase of 22,302 in Ingham County, 14,612 was contributed by natural increase and 7,690 was the result of the addition of migrants. In Dickinson County, the population in 1947 was 5,363 less than in 1940 despite an excess of 2,022 births over deaths, which means that the population decrease in this county was the result of 7,385 persons migrating from it during this period.

In every one of the 83 counties, births exceeded deaths, amounting to as little as 37 in Keweenaw County and as much as 191,819 in Wayne County. Despite the fact that every county experienced a natural increase from 1940 to 1947, 27 counties lost in population during this period, owing to extensive migration from them.

On the basis of their 1940 populations, natural increase added substantially to the increase in population during the past 7 years in the counties of Bay, Chippewa, Genesee, Gladwin, Isabella, Macomb, Midland, Muskegon, Oakland, Ottawa, Presque Isle, Saginaw, Washtenaw, and Wayne. In these counties the natural increase amounted to 9 percent or more of the 1940 population.

Again, on the basis of their 1940 population, migration added very substantially during the 1940-47 period in the counties of Bay, Berrien, Calhoun, Cass, Clinton, Grand Traverse, Hillsdale, Iosco, Lenawee, Macomb, Midland, Monroe, Oscoda, Roscommon, St. Clair, and Washtenaw. In each of these counties the net migration into them amounted to 9 percent or more of the 1940 population. Obviously, counties which had relatively large additions both by natural increase and by migration have many more people at present than they had at the beginning of the present decade, Roscommon County as much as 69.6 percent more.

The Michigan Department of Health has also made estimates of population for 1947 for each of the 124 urban centers of the state. These population figures and those of rural areas of counties for 1947, in conjunction with school censuses by school districts for 1940 and 1947, enable one to make reasonably accurate estimates of population by communities at the present time. In this way the current ratio of population per physician, for example, can be determined quite accurately and comparison of communities in this respect will be valid.

In all probability, excess of births over deaths will continue to be considerable in all counties of the state during the next few years. The total number of births in Michigan rose from a relatively low

figure of 80,482 in 1933 to the unprecedented high of 160,315 in 1947. It is quite likely that this figure will gradually drop, probably about 15 thousand annually during the next 2 years. On the monthly basis, it seems to have reached a peak in the fall of 1947. The total number of deaths in Michigan has not fluctuated much since 1930, the lowest being 48,507 in 1933 and the highest 56,807 in 1947. The total number of deaths in the state can be expected to fluctuate around 50 to 60 thousand during the next few years. This means that, as a result of natural increase, the population of Michigan can be expected to increase about 85 thousand in 1948 and 70 thousand in 1949. The number of net migrants into Michigan this year and the next is more difficult to foresee. As long as this state maintains its present favorable economic position the law of supply and demand will undoubtedly continue to attract many industrialists and laborers from states having comparatively fewer favorable opportunities. Also, for the next few years the trend in population within most counties can be expected to continue much as it has during the past 7 years, decreasing in 20 to 30 counties and increasing in the others.

AN OIL-DISTILLATION METHOD FOR DETERMINING THE MOISTURE CONTENT OF FARM CROPS

By S. T. DEXTER
SECTION OF FARM CROPS

DURING the Michigan "Grass Days" held in June 1948, a simple method was demonstrated for determining the moisture content of grass for silage. From a weighed sample covered with a vegetable oil (Mazola corn oil), the water was removed by heating well above the boiling point of water, and the loss in weight calculated as water. This system is not new in principle, as it is the basis for the common "Brown-Duvel" moisture determination used in grain elevators, but in view of the interest aroused, a more detailed report seems desirable.

EQUIPMENT

1. An accurate spring balance, such as the Hanson Diet Scale, with a capacity of 500 or 1,000 grams. The dial of this balance turns, thus avoiding much calculation.

2. A thermometer which will read to 200° C. (392° F.).

3. A metal container, about one quart capacity. A light, seamless container is desirable. Ordinary tin cans, if not resoldered, have been found to leak at the end seams. A concave cover, with many small holes, to permit escape of steam, and a larger hole for the thermometer must be provided. Threading on the wire handle is a considerable convenience. This cover will prevent loss of oil, since occasional kernels of grain explode violently.

4. A round metal screen to keep the sample under the surface of the oil. In the center of this screen, a hole should be provided, just large enough for the bulb of the thermometer but not as large as the stem. (See 4 under "Procedure.")

ARTICLE 31-27

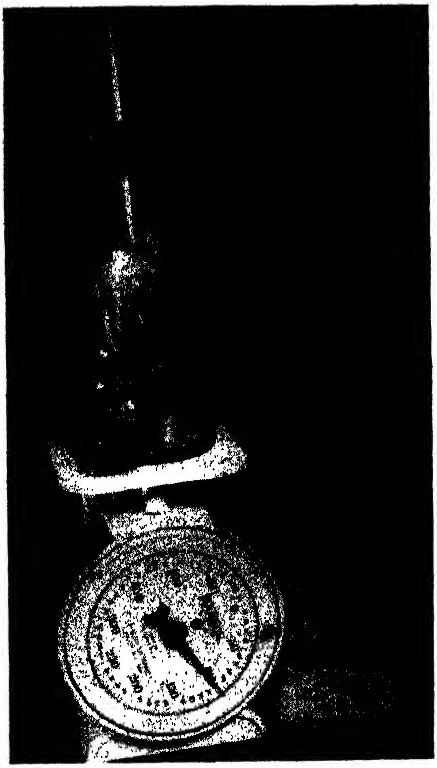

Fig. 1. The can, cover, screen, thermometer and oil used in these tests are shown. Note that the face of the scale can turn to any position.

5. Vegetable oil to cover the sample. Mineral oil tends to froth considerably.

PROCEDURE FOR HAY SILAGE

1. Weigh out 100 grams of the green hay and cut into pieces an inch or two long. Set to one side until step 2 (below) is finished.

2. Put about 200 grams of oil in the can and place it on the scale, together with the thermometer and the round screen. Turn the face of the scale to read zero at the needle, thus balancing the scale, without the sample. Tap the side of the balance before taking a reading or setting at zero. This improves the accuracy.

3. Place the hay sample in the can and drop the circular screen on top of the sample.

4. Insert the thermometer through the hole in the cover, put the bulb in the hole in the screen and press the sample under the oil. Push down occasionally during the heating process.

5. Heat (any vigorous source of heat is acceptable) until the temperature reads 145° C. (293° F.). This should take 15 or 20 minutes, starting with cold oil.

6. Now place the can with its contents, including the thermometer, on the scale and let stand for a moment or two until there is no change in weight. Since the can, oil, thermometer and screen were balanced at zero, just before the hay was put in, the increase in weight – say 28 grams – is the dry weight of the hay sample, and 28 percent

TABLE 1–*Moisture content of various samples of green hay, as cut, on several dates. The oil-distillation method with one 100-gram sample compared with the laboratory electric oven at 103° C., where three 30-gram samples were used except as shown*

Date	Kind of hay	Oil method distillation	Electric oven	Remarks
June 3	Alfalfa	78.7	76.1	Soil very dry
	Ladino clover	84.2	85.9	
	Red clover	83.0	84.1	
	Sweet clover	82.3	83.1	
		Av. 82.1	Av. 82.3	
June 10	Alfalfa	79.0	77.8, 79.3, 78.3	Note the variations in three samples from the same lots of hay
	Brome grass	75.8	73.2, 76.4, 74.3	
	Alsike clover	80.1	77.9, 80.3, 79.8	
	Red clover	77.3	80.1, 79.1, 74.1	
	Sweet clover	75.3	80.1, 78.5, 77.5	
	Ladino clover	84.4	83.8, 84.6, 84.0	
		Av. 78.7	Av. 78.9	
June 18	Alfalfa	76.2	74.5, 73.0, 75.8	½ bloom, samples somewhat damp with dew
	Brome grass	69.0	65.6, 68.4, 67.9	
	Alsike clover	79.9	79.6, 80.4, 78.1	
	Red clover	75.0	74.4, 75.1, 75.3	
	Sweet clover	81.0	80.3, 80.7, 81.2	
	Ladino clover	84.2	84.5	
		Av. 77.7	Av. 76.4	
July 12	Alfalfa	75.4	73.5, 73.3, 74.0	Past bloom, but leafy
	Brome grass	57.2	57.9, 55.9, 58.4	Past bloom, but leafy
	Alsike clover	66.5	68.4, 62.6, 68.7	Most flowers brown
	Red clover	70.3	72.8	¾ flowers brown
	Sweet clover	76.4	76.9, 76.7, 76.5	Past bloom, but leafy
	Ladino clover	81.7	82.6, 84.6, 83.5	Second growth
		Av. 71.2	Av. 72.1	

is the dry matter content of the green hay. 100 grams of green hay minus 28 grams of dry matter gives 72 grams, or 72 percent of water, which was boiled off in "French-frying" the hay. Table 1 shows the results of determinations on various hays when fresh cut.

PROCEDURE FOR GRAIN

The procedure for grain is much as described above except that a temperature of 145° C. or even 170° C. is inadequate to give values that agree with the official Brown-Duvel apparatus. When the temperatures recommended for that apparatus are used in the new method [about 190° C. (374° F.) for most grains] the agreement is excellent. With grain at ordinary moisture contents, 200-gram samples may be used conveniently in the present method. This may slightly increase the accuracy, since the scale can hardly be read to a figure less than half a gram. **Tapping the scale before reading greatly improves the accuracy.** Always tap before and after setting the balance at zero, or taking a reading. Table 2 gives data on moisture in corn grain.

DISCUSSION

A simple method of determining the moisture content in various materials consists in distilling off the water contained in the weighed material by heating in a bath of surrounding oil, and determining the

TABLE 2—*Average percentages of moisture obtained from shelled corn of various moisture contents compared, using the oil-distillation method and the official Brown-Duvel method*

Sample	Temperatures of oil with oil distillation			Brown-Duvel
	145°C	170°C	190°C	
	Moisture content			Moisture content
	Percent	Percent	Percent	Percent
1	10.0	12.1	12.0	12.8
2	12.2	13.2	14.0	14.3
3	13.4	14.9	15.6	15.6
4	15.9	16.8	17.0	17.0
5	16.0	17.3	17.7	17.7
6	16.5	18.0	18.2	18.2
7	19.2	20.8	20.8	20.8
8	23.6	25.5	25.7	25.7
9	25.2	26.5	27.1	27.1

loss of water by loss in weight. The oil effectively prevents local overheating or burning, and yet permits the use of a large amount of heat and very rapid evaporation. This is an advantage over the exhaust pipe oven method (1), on green hay samples and with grain, where there is no particular object in having a large, bulky sample as in dry hay.

A temperature of 145° C. (293° F.) has been found to be a suitable final temperature of the oil in determining moisture in hays and silages, since the figures so obtained agree well with determinations made in the electric oven at 103° C. The temperatures recommended for the Brown-Duvel apparatus should be followed when using the new methods, to get values that agree on grain.

In numerous determinations of moisture in grass silage with the new method, it was found that approximately 1 ounce of oil was absorbed by the sample. Materially less than this is absorbed per sample of grain. The remaining oil may be strained through the screen and used over and over again.

While this method has been found accurate for dry hay, the weight of the sample must be reduced to 25 or 50 grams, because of the greater bulk, and large amounts of oil are absorbed, when the dry weight of the sample is greater. Since it is extremely difficult to take small representative samples of dry hay, it is an advantage to determine the moisture content of larger samples by a method previously described (1) which uses the same diet scale used above.

Although the method is extremely simple, certain precautions may be mentioned. With very coarse material, such as woody sweet clover, sudan grass, etc., it is desirable to take the full 20 minutes of heating, because the stems are larger and the water is driven out more slowly. With ordinary fine-stemmed hay, all the water is expelled, even in a 10-minute heating period if a temperature of 145° C. is reached. Heating above 145° C. is likely to scorch the hay and give values for moisture content that are somewhat above those of the laboratory oven method. The errors obtained by slight overheating are relatively small, however, and if the temperature should happen to go to 155° C. or 160° C. the difference in weight, owing to further evaporation of moisture, is hardly detectable on the scale.

CONCLUSION

Any farmer can make this equipment, with the exception of the diet scale, costing about $10, and the thermometer, costing about $2. Otherwise, kitchen utensils, and various sources of heat, already available, can be used. On our "Grass Days," the author used the exhaust pipe oven (1) as a heater, but in the laboratory, as in a kitchen, a gas or electric plate was used. By using a 100-gram sample and a diet scale, all computation is eliminated. The accuracy of the method as described seems adequate for ordinary farm purposes.

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JOURNAL ARTICLE ABSTRACTS

Productiveness of Bromegrass Strains from Different Regions when Grown in Pure Stands and in Mixture with Alfalfa in Michigan

CHURCHILL, B. R.

Jour. Am. Soc. of Agron. 39 (19): 750-761. 1947. [Journal Article 824 (n. s.) from the Michigan Agricultural Experiment Station]

Bromegrass strains from several states and Canada were grown in pure stands and in mixture with alfalfa and harvested as hay from 1941 to 1945.

Mixtures yielded more than either crop in pure stand. Growing bromegrass and alfalfa in mixture reduced the acre yield of each individually as compared with yields of these crops when each was grown alone.

Strains differed in yield, and this difference was greater when strains were grown in pure stand than when they were grown in mixture with alfalfa. None of the strains produced a second cutting when grown in pure stands but did make some growth in second cutting when in mixture with alfalfa.

When cut for hay, the percentage of protein in the bromegrass was twice as high from the second cutting as from the first. Strains differed in percentage of protein depending upon stage of maturity at same time of cutting. With one exception, bromegrass strains in alfalfa mixtures contained a higher percentage of fiber than when grown alone. Kansas and Nebraska strains were earliest, and a strain from Russia was latest in maturity.

It was concluded that the percentage of bromegrass in an alfalfa bromegrass mixture was more important in Michigan than choice of bromegrass strain. The strain of bromegrass influenced this percentage in some cases but rate of seeding of the bromegrass was considered the most important factor.

A Suggested Modified Procedure for Testing Homogenized Milk

LUCAS, P. S. AND TROUT, G. M.

Jour. Dairy Sci. 30 (2): 95-102. 1947. [Journal Article 839 (n. s.) from the Michigan Agricultural Experiment Station]

The objective of this study was origination of a modification of some test for milk fat which would give results comparable to those obtained by the Mojonnier method for fat in homogenized milk. The Babcock test modified in the manner described below gave such results.

Sulfuric acid was used, testing 1.83 to 1.835 specific gravity and was used in the sample of milk which had been tempered to 70° F. in the amount of 17.5 ml. The acid was also added at 70° F. and was added in three portions, with agitation after each addition. Clearer fat columns were obtained when water mixed with alcohol in the ratio of 1.4:1 by weight was added to the fat column before the final centrifuging. Except for these changes, the test was run as with the ordinary Babcock method.

Thirty-six samples of homogenized milk were run, and these averaged 0.018 percent lower than the average for the same milk not homogenized. The variation of the 36 tests run by the Mojonnier method were +0.058 percent and +0.045 percent for the unhomogenized and homogenized milks respectively.

Corn Meal and Macaroni Products Containing Dry Primary Yeast. I. Palatability and Acceptability

PAUL, PAULINE, FRUEH, M., AND OHLSON, M.

Jour. Am. Dietetic Assoc. 24 (8): 673-675. 1948. [Journal Article 873 (n. s.) from the Michigan Agricultural Experiment Station]

The changes in acceptability caused by addition of varying amounts of dry primary yeast to corn meal and to macaroni products have been investigated. Yellow and white corn meal, with 0, 1-, 2-, and 3-percent added yeast, have been tested in corn meal mush, corn dodgers, and corn bread. Macaroni made with 0, 2½-, 3-, 4-, and 7-percent added yeast was tested as boiled macaroni, macaroni and cheese, and macaroni with tomato and bacon.

The palatability of the yellow corn meal products decreases as the concentration of yeast increased. This trend was also exhibited in the white corn meal products, but was not as clearly defined. The concensus was that 1 percent of yeast could be added to corn meal without pronounced change in acceptability, but that more than that could be detected.

The scores for boiled macaroni decreased markedly with addition of yeast. Even 2½ percent was readily detected, although there was little difference between 2½ and 3 percent yeast concentrations. When the macaroni was prepared with additional flavoring materials such as cheese or tomato, onion and bacon, the macaroni could contain 4 percent yeast without decreasing the palatability appreciably. The judges' decision was that boiled macaroni was not a good carrier for yeast, but that macaroni in products containing other pronounced flavors could carry 4 percent yeast.

Influence of Thyroid Status on the Electrocardiogram and Certain Blood Constituents of the Sheep

MULLICK, D. N., ALFREDSON, B. V. AND REINEKE, E. P.

Amer. Jour. of Physiology 152 (1): 100-105. 1948. [Journal Article 877 (n. s.) from the Michigan Agricultural Experiment Station]

The thyroid status of domestic sheep was modified experimentally by means of thyroidectomy followed by thyroprotein therapy and also by the administration of thiouracil. Under each of the experimental conditions data were obtained on the EKG and certain constituents of the blood.

In the EKG studies the outstanding deviations from the normal following thyroidectomy were a decrease in heart rate and a decrease in potential of the T wave. Thyroprotein administration at the rate of 1 and 2 grams per 45 kgm. body weight restored the EKG pattern to normal or above. Thiouracil administration resulted in a typical increase in potential of the T wave in addition to some reduction in heart rate.

The "blood fat" as determined on serum by the method of Allen did not show the expected rise following thyroidectomy. The blood fat level declined slightly, however, after treatment with thyroprotein. Thiouracil administration resulted in a sharp and highly significant increase in the blood fat levels. No appreciable alterations in the blood sugar level after thyroidectomy or treatment with thiouracil were noted. There was a small, but statistically insignificant, rise in the blood sugar when thyroprotein was fed.

No deviations that could be related to the thyroid status were observed in the blood hemoglobin content or the serum protein, calcium, phosphorus or magnesium.

A Comparative Study of the Use-Dilution Method and the F. D. A. Phenol Coefficient Method Applied to Some Veterinary Disinfectants

MALLMANN, W. L. AND LEAVITT, A. H.

Am. Jour. Vet. Res. 9 (30): 104-108. 1948. [Journal Article 896 (n. s.) from the Michigan Agricultural Experiment Station]

The use-dilution method makes possible the testing of the actual concentration of the disinfectant used in practice rather than the minimum killing concentration. The procedure is outlined fully. The results show that some of the veterinary disinfectants tested showed killing dilutions below those recommended by the manufacturers when tested with *Staph. aureous.*

Corn Meal and Macaroni Products Containing Dry Primary Yeast. II. Nutritional Studies

CEDERQUIST, D. C., BENNET, B. V., PLUMMER, J. A., AND OHLSON, M. A.

Jour. Am. Dietetic Assn. 24 (8): 676-678. 1948. [Journal Article 900 (n. s.) from the Michigan Agricultural Experiment Station]

The changes in nutritive value resulting from the addition of dry primary yeast to corn meal and macaroni have been investigated. The cooked cereals with 1- and 3-percent added yeast were fed to weanling rats. Growth studies indicate that the addition of yeast to these cereals results in a slight improvement in their nutritive value. In an attempt to identify the factor in yeast responsible for the stimulation of growth, corn meal was supplemented with corn gluten or heated soybean flour with and without synthetic thiamin, riboflavin and niacin equivalent to that contained in the added yeast. Macaroni was supplemented with soybean flour with and without added vitamins. It appears from these studies that the increased rate of growth may be related to the addition of high quality protein.

It was concluded that while the addition of yeast improves the nutritive value of both corn meal and macaroni the improvement is slight unless more than 3 percent can be added. It must be recognized that most cereal enriched with as little as 5 percent yeast would be rejected by the consumer unless the flavor could be masked with other seasonings.

Cobalt Toxicity in Calves Resulting from High Oral Administration

ELY, RAY E., DUNN, K. M., AND HUFFMAN, C. F.

Jour. of Animal Sci. 7 (2): 239-248. 1948. [Journal Article 902 (n. s.) from the Michigan Agricultural Experiment Station]

The essentiality of minute quantities of cobalt in the rations of the ruminant has been amply demonstrated. However, the ease and likelihood of administering many times the required makes a knowledge of toxic levels and factors affecting cobalt toxicity of prime importance.

Male dairy calves fed toxic levels of elemental cobalt in the form of the sulfate, chloride or carbonate showed no difference in the length of time required to produce toxic symptoms. This indicates that the type of cobalt salt does not influence the toxicity of elemental cobalt.

Increasing the protein content of the ration by adding casein to a simple grain mixture did not reduce the toxicity of orally administered cobalt to calves.

Feeding a wide range of oral dosages of elemental cobalt to calves showed that dosages in excess of 50 mg. daily per 100 pounds of body weight had a detrimental effect on appetite in all cases. Oral dosages of elemental cobalt less than 40 mg. daily per 100 pounds of body weight are in the safe range of feeding. However, dosages of 3 to 5 mg. per 100 pounds of body weight are effective in overcoming cobalt deficiency.

Use of Certain New Materials in the Control of Potato Insects in Michigan

MOROFSKY, W. F., AND MUNCIE, J. H.

Am. Potato Jour. 25 (6): 255-259. 1948. [Journal Article 930 (n. s.) from the Michigan Agricultural Experiment Station]

Field tests of insecticides and fungicides were made at the Lake City Experiment Station during 1947 using the Menominee variety. Spray plots consisted of four rows 180 feet long, randomized and replicated three times. The dust plots consisted of eight rows, 200 feet long. Yields were taken from four harvestings of the two center rows 50 feet long in each plot. The soil was of clay loam and of irregular fertility. Potatoes were irrigated five times during the season.

Parathion (3422), benzene hexachloride, pyrethrins, nicotine sulfate (liquid and dry concentrate) and dry wettable and liquid DDT were used in combination with various fungicides as sprays and dusts. Tests comprised 15 dusts and 19 sprays. Applications were made every 10 days beginning July 15 to September 19. Insect counts were made 2-4-6-8 days after each application.

Best control of potato insects in general was accomplished by applications of DDT in either sprays or dusts. Parathion (3422) was outstanding in control of potato leafhopper by dusting while applications of 5 percent DDT gave almost complete control of six-spotted leafhoppers, flea beetles, and tarnished plant bugs. Benzene hexachloride as a dust ranked with DDT in the control of tarnished plant bugs, although this was not true in control of leafhoppers nor in the spray combinations. No late blight was present. There was no significant difference between materials in control of early blight due to early killing frost.

A Combination of the Resazurin Test and the Direct Microscopic Count for the Bacteriological Examination of Milk

BORTREE, A. L., AND SPENCER, R. D.

Jour. of Milk and Food Technology 11 (5): 255-258, 268. 1948. [Journal Article 934 (n. s.) from the Michigan Agricultural Experiment Station]

A study was made of the conditions under which the one-hour resazurin test could be substituted for other laboratory tests without significantly changing the results obtained. It was found that milk samples placed in Class 1 by the reduction tests are, in a very high percentage of the cases, of low bacteria count. Samples placed in Class 4 are definitely of inferior quality and a microscopic examination should be made to determine the cause of low quality. It was suggested that the resazurin test be used as a screening test to eliminate high quality samples from further examination and as a means of detecting the definitely low quality milk and as a guide for further examination and field work.

The Nutritive Value of Homogenized Milk: A Review

TROUT, G. M.

Jour. of Dairy Sci. 31 (8): 627-655. 1948. [Journal Article 944 (n. s.) from the Michigan Agricultural Experiment Station]

A complete survey of the literature relative to the nutritive value of homogenized milk was made. The paper contained 136 citations. The following conclusions concerning homogenized milk were made:

The homogeneity of properly processed homogenized milk assures equal distribution of the fat, vitamin A, and added vitamin D to those who consume the milk. Homogenization retards or inhibits the development of the copper-induced oxidized flavor over an extended period of time. Thus, the milk properly stored and refrigerated retains the fresh flavor which contributes much to its palatability.

The smooth, uniform consistency of properly homogenized milk, as shown by the absence of cream flecks, non-miscible cream or butter granules, further contributes to its palatability.

Proper homogenization changes normal hard curd milk to a soft curd milk which appears to be digested slightly more easily but neither more quickly nor more completely than hard curd milk despite a faster stomach-emptying time.

Reduction in the size of the fat globules by homogenization does not increase the digestibility of the fat, since the digestibility of the fat of fresh whole milk is so nearly complete that any marked increase in digestibility is not possible.

Homogenized milk has been used successfully in the preparation of infant formula and in infant feeding.

The ingestion of homogenized milk seems to be associated with a lack of distress and a sensation of overfullness during digestion. Hence, homogenized milk would seem to be especially suited for hospital dietaries.

The Value of a "Hormone" Spray for Overcoming Delayed Fruit Set and Increasing Yields of Outdoor Tomatoes

WITTWER, S. H., STALLWORTH, H., AND HOWELL, M. J.

Proc. Amer. Soc. Hort. Sci. 51: 371-380. 1948. [Journal Article 947 (n. s.) from the Michigan Agricultural Experiment Station]

Water sprays of para-chlorophenoxyacetic acid, 25 ppm. applied to the first (crown) flower clusters of field tomatoes resulted in the production of significantly more and larger early fruit. In a comparative trial involving Victor, an early variety, and Rutgers, a late variety, fruits were picked twice from treated Rutgers before any were harvested from plants of Victor which were not sprayed. Treated Victors, on the other hand, matured a pound of fruit per plant before tomatoes were picked from controls of the same variety. Spraying the first three flower clusters on plants of a late crop of Rutgers grown for canning resulted, for the total crop harvested, in a significant yield increase of 27-percent and a 11-percent increase in fruit size. The frequent occurrence in Michigan of night temperatures too low for optimum fruit setting is offered as the probable explanation for the striking results obtained. The data suggest that "hormone" spraying of flower clusters may be profitable practice in the production of early tomatoes grown in regions adjacent to large bodies of water, in northern states, on muck soils, in mountainous areas, or in any locality or season having prevailing minimum night temperatures during the normal period of fruit setting of less than 59° F.

A Survey of the Incidence of Serological Variants of Salmonella Pullorum in Michigan.

BIVINS, J. A.

Poultry Science. 27 (5): 629-634. 1948. [Journal Article 948 (n. s.) from the Michigan Agricultural Experiment Station]

It was felt that a survey to determine the incidence of "variant" strains of S. *pullorum* among cultures isolated from fowl presented for diagnosis at the Poultry Clinic of Michigan State College might aid in evaluation of the importance of this aspect of the Michigan pullorum disease control plan. Two hundred and two strains of S. *pullorum* isolated from consignments presented for diagnosis at the Poultry Clinic and six laboratory strains were classified as variant or standard type according to their reaction with *Proteus* and with S. *paratyphi* A var. Durazzo antisera. The serum-plate test was used. Thirty-one strains (15 percent) of the variant type were found. The results of the serum-plate test were in good agreement with the results of the tube test.

A Comparison of Three Enrichment Media for the Isolation of Salmonellae from Poultry

BIVINS, J. A., AND BLEIL, V. P.

Proc. Soc. of Am. Bacteriologists 1 (1): 40. 1948. [Journal Article 949 (n. s.) from the Michigan Agricultural Experiment Station]

An attempt was made to determine the relative value of mandelic acid, selenite F, and tetrathionate enrichment media for the recovery of Salmonellae from poultry. The study was pursued in two parts: 1) the isolation of pathogens from specimens presented for diagnosis and, 2) the recovery of S. *pullorum* from rectal swabs of turkey poults known to have survived an outbreak of pullorum disease during the brooding period. From 33 cases suspected of having a Salmonella infection, 85 tissues were collected. Positive cultures of these tissues were obtained as follows: direct culture (no enrichment) on S. S. agar, 46 (54 percent); mandelic acid, 57 (67.1 percent); selenite F, 66 (77.6 percent); and tetrathionate, 53 (62.4 percent). Fifteen tissues from 7 cases were positive in all enrichment media. If these are omitted, a more striking variation is evident: direct culture, 47 percent positive; mandelic acid, 60 percent positive; selenite F, 72.9 percent positive; tetrathionate, 54 percent positive. Selenite F was the best medium.

Four rectal swabbings were made from 35 young turkeys between the 13th and 21st weeks of age. The swab samples were suspended in nutrient broth and then cultured in each of the three enrichment media. S. *pullorum* was recovered only on the first two swabbings and then in only 8 birds. Of these, only 3 yielded positive cultures twice. No significant difference was observed in the value of the three media; mandelic gave 5 positive; selenite F, 6 positive; tetrathionate, 5 positive. *Streptococcus faecalis* grew well in tetrathionate broth but was inhibited in the other two media. Inhibition of paracolons was less marked but of the same order.

Further Studies on the Relationship of Nicotinic Acid, Tryptophane and Protein in the Nutrition of a Pig

LUECKE, R. W., MCMILLEN, W. N., THORP, F., AND TULL, CAROLYN

Jour. of Nutrition 36 (3): 417-424. 1948. [Journal Article 953 (n. s.) from the Michigan Agricultural Experiment Station]

Adequate amounts of DL-tryptophane as supplements to a low-protein corn ration will prevent nicotinic acid deficiency in the pig. Supplementation of the same low protein ration with nicotinic acid seems to increase the utilization of dietary tryptophane.

No symptoms of nicotinic acid deficiency were produced on a corn ration containing 25 percent casein. Moreover, pigs fed this high protein ration grew very rapidly and required only 1.96 pounds of feed to produce 1 pound gain in body weight.

Mild symptoms of nicotinic acid deficiency were produced in pigs whose calculated average daily intake of nicotinic acid was 17.4 mg.

Studies on the Heat Inactivation of Lysine in Soybean Oil Meal

EVANS, R. J., AND BUTTS, H. A.

Jour. Biol. Chem. 175 (1): 15-20. 1948. [Journal Article 954 (n. s.) from the Michigan Agricultural Experiment Station]

Two types of heat inactivation of lysine were observed when soybean oil meal was autoclaved for 4 hours. Approximately 40 percent of the lysine, both that present in the soybean oil meal and that added as DL-lysine hydrochloride, was

destroyed as determined by assay with *Leuconostoc mesenteroides* after acid hydrolysis. Sixty percent less lysine was liberated by enzymic digestion *in vitro* from the autoclaved than from the unautoclaved meal. Twenty percent of the added lysine was converted to a form from which active lysine was freed by acid but not by enzyme hydrolysis *in vitro*. Very little loss of lysine occurred when soybean protein was autoclaved in the absence of sucrose, but approximately 25 percent of the lysine was converted to a form from which biologically active lysine was liberated by acid but not by enzyme hydrolysis *in vitro*. The addition of 20-percent sucrose to the soybean protein resulted in a 50-percent destruction of the lysine by autoclaving.

A Comparison of Electric Resistance Units for Making a Continuous Measurement of Soil Moisture Under Field Conditions

BOUYOUCOS, G. J., AND MICK, A. H.

Plant Physiology 25 (4): 532-543. 1948. [Journal Article 955 (n. s.) from the Michigan Agricultural Experiment Station]

1. The electrical resistance technique of obtaining a continuous measure of soil moisture "in Situ" under field conditions by means of absorption units is discussed in the light of additional knowledge and experience gained since the inception of the method in 1940.

2. Fundamental considerations of the characteristics of this technique reveal that for most practical purposes standard plaster of Paris absorption blocks need not be calibrated. Resistance readings may be directly interpreted in terms of available soil water; in all soils the percentage of available water is approximately the same for any given resistance value.

3. Several types of absorption units are described and compared by means of laboratory calibration curves. Some of these units offer great promise of measuring soil moisture from saturation to dryness.

4. The advantages of the method are summarized.

Report on Zinc in Plants

SHIRLEY, R. L., WALDRON, D. R., JONES, E. D., AND ASSOCIATE REFEREE E. J. BENNE

Jour. of the Assoc. of Offic. Chem. 31 (2): 285-293. 1948. [Journal Article 957 (n. s.) from the Michigan Agricultural Experiment Station]

During the 1945 revision of Methods of Analysis, A.O.A.C., the dithizone method for determining zinc in plant materials was introduced into the Plant Chapter as a tentative method to replace the former H_2A-ferrocyanide procedure. The dithizone method depends upon the combination of zinc with dithizone (diphenylthiocarbazone) in an ammonical solution of controlled reaction to form a red compound. This compound and some excess dithizone are extracted from aqueous solutions into carbon tetrachloride, and the zinc present is evaluated photometrically by a mixed-color procedure.

This report is a progress report of the Associate Referee and the following aspects of the dithizone method for the determination of zinc in plants have been investigated:

1. The spectral properties of carbon tetrachloride solutions of dithizone and zinc dithizonate, individually, and together as used in the mixed-color method.

2. The effect of daylight upon the spectral properties of these solutions and means of protecting them against such effects.

3. The following points in the mixed-color procedure:

a) Amount of dithizone reagent necessary when the concentration of zinc is high.
b) Standardization of the rising process when carbon tetrachloride after extraction of the aqueous solution with dithizone reagent.
c) Effects of using a stock solution of carbamate reagent which was stored in a refrigerator.

4. a) The practicability of removing excess dithizone from the carbon tetrachloride solutions of zinc dithizonate and using a one-color instead of mixed-color procedure.
   b) Determination of the accuracy with which known quantities of zinc added to extracts of plant ash, plus the zinc present in the extract, could be evaluated by use of this procedure.

5. Reproducibility of results by the mixed-color and one-color procedures when used by four different analysts in an intra-laboratory study.

A Liquid Germicidal Detergent in Veterinary Surgery

BRYAN, C. S., BRINKER, W. O., SALES, E. K., YOUNG, F. W., GRAFTON, T. S., AND HUTTON, J. P.

Vet. Med. 43 (8): 324-329. 1948. [*Journal Article 962 (n. s.) from the Michigan Agricultural Experiment Station*]

The liquid germicidal detergent (a suspension of high molecular weight alkylamide hydrochlorides containing 25 percent of a quaternary ammonium chloride compound) studied was satisfactory as a skin cleanser and a disinfectant when used undiluted, or in a dilution of one part to five with water. Swab bacteria counts were made and sections of skin were examined bacteriologically to determine the value of liquid germicidal detergent as a skin disinfectant. Over 140 operations have been successfully performed on small and large animals following the pre-operative preparation of the operative area with liquid germicidal detergent. A solution of liquid germicidal detergent (one ounce to the gallon of water) is recommended for udder disinfection in a program of quality milk production and control of udder infection.

The QUARTERLY BULLETIN

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Agricultural Experiment Station
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CONTENTS

(Continued on Next Page)

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: (1) progress reports on long-term major research projects; (2) final reports on short-term projects and (3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

CONTENTS

(Continued from Outside Front Cover)

TWO NEW VARIETIES OF OATS FOR MICHIGAN

By E. E. DOWN
SECTION OF FARM CROPS

TWO NEW VARIETIES of oats were increased in 1948 for introduction to Michigan farmers. Both of these varieties are the result of the combined effort of the Farm Crops Department of Michigan State College and members of the Office of Oat Investigations of the U. S. Department of Agriculture.

The services of the Office of Oat Investigations have been of great value in the development of these varieties. Material for breeding purposes is collected from all parts of the world and tested for disease resistance. Resistant material is combined or crossed with old varieties to produce new and better genetic combinations of oat characters for this country. Material in varying degrees of genetic purity resulting from these crosses is sent to interested state agricultural experiment stations for testing and further selection. A large number of recently introduced varieties have been developed in this manner. This is also true of the two varieties described herein.

Kent and Bonham are the names given two new varieties of oats increased for the first time in 1948. They were selected from a cross made between Bond and D69. The Eaton variety, familiar to many Michigan growers, has Bond as one of its parents. Bond is an Australian variety, highly resistant to smut and most of the common forms of leaf or crown rust. However it is susceptible to leaf rust strain No. 45 that is increasing in importance in the corn belt states. D69 is the number given a selection from a cross between Richland and Green Russian oats. D69 is resistant to the common forms of stem rust that appear in Michigan. Both Kent and Bonham carry rust resistance similar to the yellow Clinton variety from Iowa.

Kent is a high-yielding, early-maturing, white-grained variety, medium in straw length, and having a high test weight. The straw is slightly weaker than that of Eaton, at least in some years and in some sections of the state.

ARTICLE 31-28

TABLE 1—*Agronomic comparison at East Lansing of Eaton, Huron, Kent and Bonham oat varieties*

Variety	1941	1942	1943	1944	1945	1946	1947	1948	Average
Yield in bushels per acre									
Eaton	75.5	95.4	47.9	77.1	85.2	81.2	78.1	74.6	76.9
Huron	76.8	95.5	37.0	81.0	79.6	84.8	72.0	89.1	77.0
Kent	76.5	98.5	40.9	83.0	84.9	82.7	71.8	74.9	76.7
Bonham	....	....	....	....	....	....	64.4	70.6	*67.5
Test weight in pounds per bushel									
Eaton	35.7	34.0	29.5	35.3	36.4	36.7	32.3	34.9	34.4
Huron	37.5	36.3	28.8	39.0	37.6	36.8	34.4	37.7	36.0
Kent	38.5	36.0	34.5	37.5	37.8	39.6	35.9	37.3	37.1
Bonham	....	....	....	....	....	....	32.7	36.0	*34.4
Date in July when ripe									
Eaton	11	18	24	14	26	17	23	13	18
Huron	15	20	24	21	26	19	23	13	20
Kent	14	18	24	14	26	17	23	13	19
Bonham	....	....	....	....	....	....	23	13	*18
Height in inches									
Eaton	37	45	40	41	42	44	37	44	41.3
Huron	39	50	42	45	45	47	39	51	44.8
Kent	37	46	40	40	43	44	40	43	41.6
Bonham	....	....	....	....	....	....	40	43	*42.0
Lodging, in percent									
Eaton	0	4	0	0	0	0	0	0	0.5
Huron	0	10	15	0	0	0	0	3	4.5
Kent	0	4	5	0	0	0	0	0	1.0
Bonham	....	....	....	....	....	....	0	0	*0

*2-year average.

Kent is recommended especially for the "Thumb" and Saginaw Valley where a white-grained variety with a high test weight is desirable. It should be planted after corn or sugar beets. It should be adapted to other parts of the lower peninsula where lodging is not too serious. It is not intended that the Kent variety should replace Eaton in Michigan. It should be a good replacement for Huron since it has as high a test weight and has rust resistance that Huron lacks.

Bonham is a high-yielding, smut- and rust-resistant, and early-maturing reddish-yellow-grained variety, medium in straw height, with high test weight. It is recommended for the upper peninsula. This variety was selected at the Upper Peninsula Experiment Station at Chatham by a former staff member, Evert Vandermulen. Increase of

the selections and testing in 1947 and 48 were made at the East Lansing station. At present, information on this variety indicates that its growth should be limited to conditions similar to those in the upper peninsula.

Fortunately, Kent and Bonham like Eaton are resistant to the new root-rot disease *(Helminthosporium victoriae)* that is doing so much damage. This disease was observed officially in Michigan in 1948 in the southern three tiers of counties. Many fields of Vicland were practically worthless in these counties.

SEED SUPPLY

Kent and Bonham varieties are being released through the Michigan Crop Improvement Association. Seed of Kent will be allocated to Michigan producers of certified seed and to others interested in certification. The same is true of Bonham, except distribution will be limited to upper peninsula growers.

Some 80 and 16 acres of Kent and Bonham respectively passed field inspection in 1948. Field returns have not been received on Bonham, but one field of 18 acres of Kent on the Herbert Gettel farm near Pigeon yielded 101 bushels per acre of 38-pound oats (uncleaned).

THE EFFECT OF IRRIGATION ON THE HUMIDITY IN ORCHARDS

By F. W. PEIKERT and R. T. TRIBBLE
SECTION OF AGRICULTURAL ENGINEERING

THE QUESTION is sometimes raised as to whether sprinkler irrigation in orchards will cause the spread of certain fungus diseases. The reason for this concern is that periods of high humidity are considered favorable for the spread of such diseases.

A study was made during August 1948, in an apple orchard in Van Buren County, Michigan, to compare the humidity in the immediate vicinity of irrigation with that in the surrounding orchard.

CONDITIONS PRESENT IN AREA OF STUDY

The data were collected in a mature apple orchard with heavy sod cover on a gently rolling topography that was being irrigated by a conventional portable pipe sprinkler system. This equipment consisted of a single line of pipe laid on the surface of the ground with revolving sprinklers spaced 42 feet, and each discharging about 20 gallons per minute. The nozzles of these sprinklers were about one foot above the pipe and the discharge from each sprinkler covered a diameter of about 120 feet. The irrigation line was allowed to run 4 hours in one location and then moved over 60 feet to a parallel position. Since the sprinklers were of the conventional field type, the stream of water reached a maximum height of about 10 feet above the ground in trees that averaged 20 to 25 feet tall. The sprinklers were of the two-nozzle type and made about one revolution per minute so that over most of the wetted circle the stream of water hit any one location of the foliage only a few seconds during each revolution.

Throughout the period of test it was partly cloudy. The wind velocity varied from about 2 to 3½ miles per hour and the direction was NNW to NNE. The line of sprinklers was set in a north-south direction. Further details of the weather are shown in Table 1.

ARTICLE 31-29

TABLE 1—*Weather conditions during test period*

Time	Wind direction	Wind velocity m.p.h.	Tempera-ture	Relative humidity (percent)
8:00 a.m.	NNW	3.4	69	76
9:05	NNW	3.2	71	66
9:15	NNW	2.7	73	65
9:50	NNW	3.4	76	66
10:30	NNW	2.9	77	65
11:00	N	2.0	80	57
11:30	NNE	2.4	80	60
11:44	NNE	2.3	81	58
1:04 p.m.	NNE	2.4	82	44
1:31	NNE	2.5	83	46
1:49	NNE	2.5	82	49
2:15	NNE	2.0	81	54
2:45	NNE	1.9	76	55
3:15	NNE	1.9	75	58
3:30	NNE	2.2	74	60

METHOD OF MAKING STUDY

A number of stations were set up along several lines taken perpendicular to the pipe and sprinklers. These stations were all located adjacent to trees and at 3-, 10- and 15-foot levels above the ground. The locations with respect to the sprinklers were at the tree nearest to the irrigation line and at 60-, 120-, 180- and 240-foot distances.

Initial readings of temperature and humidity were taken in the morning prior to starting irrigation and then at approximately one-half hour intervals while the system was in operation and continued after shutting down until the humidity in the irrigated zone was again the same as the surrounding area.

RESULTS

During Irrigation

Figure 1 shows the average relative humidity along a representative line of stations during the irrigation period. Readings were taken at each of the three levels and at different distances from the sprinklers.

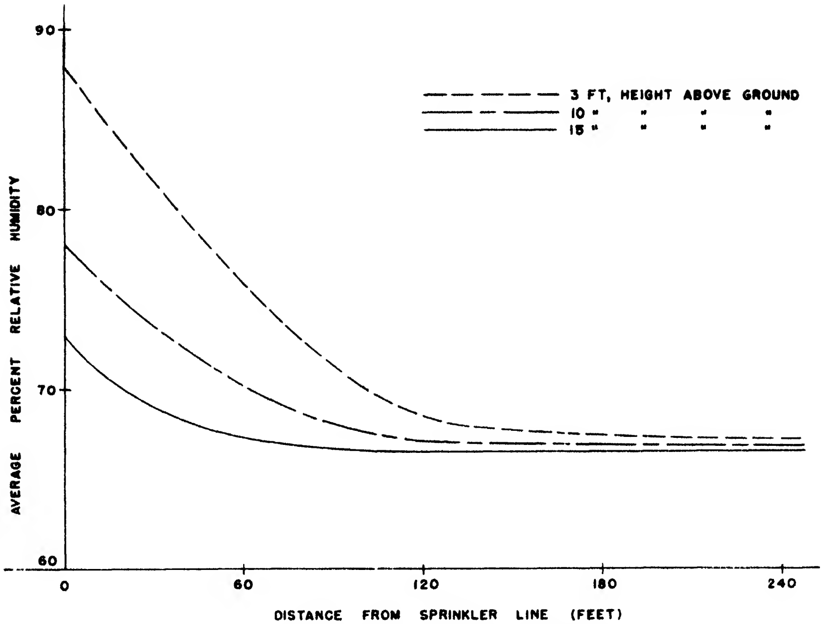

Fig. 1. Humidity variation in orchard during sprinkler irrigation.

Table 2 shows that the increase in relative humidity was considerable at all three levels immediately adjacent to the sprinklers. At a distance of 60 feet, the farthest that any of the water was distributed from the sprinklers, there was an increase in humidity of 9 percent at the 3-foot level, 3 percent at the 10-foot level and 1 percent 15 feet above the ground. Any water passing through the air at this location was practically at ground level.

TABLE 2—*Variation in humidity above normal due to irrigation*

Elevation above ground	Distance in feet from sprinkler line		
	0	60	120
	Percent	Percent	Percent
3	21	9	0
10	11	3	0
15	6	1	0

One hundred and twenty feet away from the sprinklers the irrigation had no apparent effect on the humidity even though the wind was blowing somewhat from the general direction of the irrigation line.

These results seem to indicate that any increase in humidity due to irrigation is confined within the approximate area covered by the sprinklers.

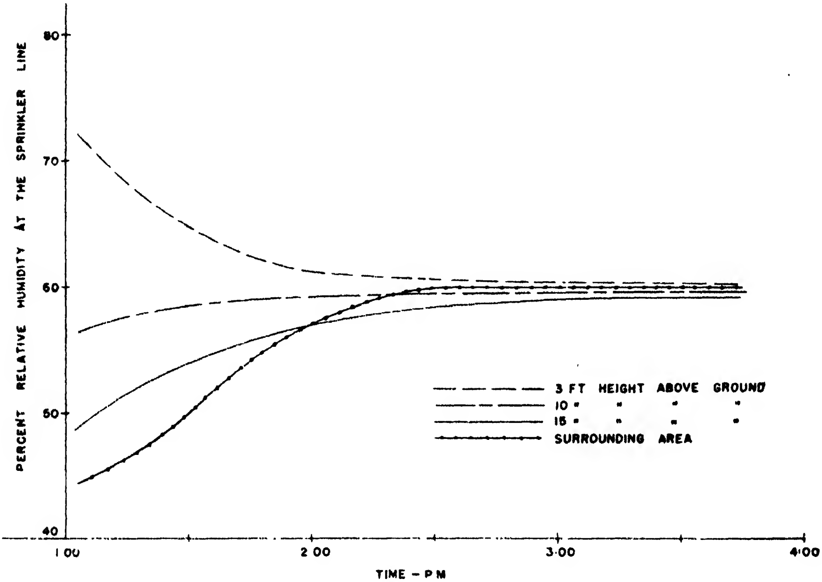

Fig. 2. Humidity variation in orchard after sprinkler irrigation.

After Irrigation

After the sprinkler line was shut off, frequent readings were taken at the line of sprinklers to determine how rapidly the humidity would return to normal. Figure 2 shows the results obtained at a typical station compared to the surrounding unirrigated area.

At the time that the first of these observations were made, the humidity of the surrounding area was considerably lower than at the test station but increased rather rapidly during the next 2 hours. Under the conditions observed, the humidity in the irrigated zone returned to approximately normal in a period of one hour. Within 45 minutes after irrigation the foliage on the trees was completely dry but some drops of water still remained on the fruit.

REACTION OF POTATO VARIETIES TO INFECTION BY *FUSARIUM EUMARTII* CARPENTER

By J. H. MUNCIE

SECTION OF BOTANY AND PLANT PATHOLOGY

POTATO FUSARIUM wilt caused by *Fusarium eumartii,* first described by Carpenter (1) and later more fully treated as a serious disease in Pennsylvania (7) is now known in several states, particularly New York (4, 5) and Nebraska (2, 3, 6). It has been known at least 20 years in Michigan, as shown by a study of organisms found in diseased tubers.* However, until recently the disease occurred only sporadically and probably was present in only trace amounts as far as our records show. In 1946, wilted potato plants were found by L. C. Knorr in certain areas of the northern part of the lower peninsula and diagnosed by him as "Z" disease as known in New York state. Later plants with symptoms typical of the disease were found in widely scattered areas in the state, including one county in the upper peninsula. In some fields losses ranged from 10 to 25 percent of the plants, although in most cases infected plants were not abundant but were scattered through the field. Although the disease was first found affecting the Russet Rural variety, it has since been found on most of the commercial varieties in the state.

In Nebraska, Goss and Jensen (3) and Jensen and Goss (6) in 1941 tested several commercial varieties and first-year seedlings for resistance to *Fusarium eumartii.* Since many new varieties have been developed since that time it was thought desirable to determine varietal susceptibility of the common commercial varieties grown in Michigan as well as to test certain unnamed seedling varieties being grown in our program for potato improvement.

*Verbal communication from M. C. Strong, Botany and Plant Pathology Department.

ARTICLE 31-30

GREENHOUSE TRIALS

Materials and Methods

Since many hybrid varieties are being developed and tested in Michigan for resistance to potato scab, several of these as well as commercial varieties were employed in greenhouse or field tests. The greenhouse test included 25 seedlings and the commercial varieties, Chippewa, Irish Cobbler, Russet Rural, Bliss Triumph, Katahdin, Sebago and Menominee.

Steamed soil was inoculated with the fungus grown on sterilized oats and in liquid culture. The soil was allowed to stand one week, thoroughly mixed and placed in steamed pots. One cut seed-piece was planted in each pot. After the plant was about 4 inches high the small roots around the edge of the pot were cut with a sterilized knife to provide wounds for more rapid entry of the organism. Four strains of the fungus were used, one pot of each series being inoculated with each strain. Three of the strains were received from C. A. Thomas, Cornell University, and the fourth was taken from the stock culture of the department and previously determined by C. D. Sherbakoff as *Fusarium eumartii.* Subsequent to these tests the fungus was isolated from Michigan-grown tubers.

Foliage symptoms were noted at frequent intervals and final readings were made 6 weeks after planting. Degree of infection was rated from 0 to 4 (none to severe with wilting and mottling of the foliage). Because greenhouse space was needed for other experiments, the tubers were harvested 8 weeks after planting. Each tuber was examined for stem-end rot and cut to determine vascular discoloration.

Results

Results of these tests are given in Table 1 and show that all commercial varieties and seedlings except Katahdin were affected under greenhouse conditions. Of the 26 seedlings, 13 showed tuber symptoms in addition to the varieties Chippewa, Bliss Triumph and Menominee. There was also considerable difference in ability of the different strains of the fungus to produce symptoms on the same potato variety. It is interesting to note that culture 215, carried in stock for 20 years, was still pathogenic.

TABLE 1—*Reaction of potato varieties to Fusarium eumartii in greenhouse trials*

Seedling parentage or commercial variety	Degree of foliage symptoms	Percentage tubers infected
Hindenburg x Katahdin	++++	13.3
A F Y-5 x 528-34	++++	12.5
A F Y-5	++++	22.2
159-1 x Katahdin	+++	15.4
Hindenburg x 528-170 X Hindenburg x Katahdin	++++	0.0
Chippewa x (Hin. x Katahdin)	+++	0.0
245-36 x (Hin. x 4-34-1-1)	+++	42.5
Chippewa x (Hin. x 528-170)	+++	6.3
245-252 x Menominee	+++	0.0
Hin. x 528-170 x (Menominee)	+++	0.0
Jubel x 245-36	++++	20.0
R. Rural x 528-102 x (Katahdin)	+++	0.0
Arnica x 528-34	++++	3.5
R. Rural x (Ostragis) x Menominee	+++	0.0
627-618 x Ostragis	+++	0.0
(627-618 x 8-1) x K 38-22	+++	10.0
627-618 x 245-36	+++	3.5
Chippewa x Menominee	++	0.0
Erie x Menominee	+++	15.4
245-252 x (Hin. x Katahdin)	++++	3.4
Sebago x 528-170	++++	18.2
Chippewa x (Hin. x Katahdin)	++++	6.6
Russet Rural	+++	0.0
Sebago	++	0.0
Menominee	+++	30.4
Bliss Triumph	++++	41.6
Chippewa	+++	25.0
Irish Cobbler	++++	0.0
Katahdin	++	0.0

FIELD TRIALS

Materials and Methods

Further tests were made with other lots of seedlings and an increased number of commercial varieties at the Lake City Experiment Station in 1948. Steamed soil, inoculated with the foregoing strains of the fungus, was spread in freshly opened furrows, and the cut seedpieces of each variety were planted by hand and immediately covered. In these tests, 24 unnamed seedlings and the commercial varieties, Menominee, Russet Rural, Erie, Pontiac, Sebago, Katahdin, Russet Burbank, White Rural, Irish Cobbler, Green Mountain, Chippewa, Bliss Triumph, Teton, Sequoia and Kennebec were employed.

The field on which this test was carried out adjoined a pond so that the water table was relatively high during the growing season. In addition, the field was overhead-irrigated four times during the season from July 25 to September 20, during a protracted drought.

Results

Results of these tests are given in Table 2, showing the reaction of the varieties as to foliage symptoms and tubers infected at harvest time. The field was planted May 17, and harvested September 22.

TABLE 2—*Reaction of potato varieties to Fusarium eumartii in field trials*

Seedling parentage or commercial variety	Percentage with foliage symptoms	Percentage with tuber infection
Ostragis x Katahdin	77.6	64.1
Jubel x 245-186	63.3	77.2
46110 x 627-218	53.3	33.7
Hindenburg x 528-170	48.3	39.4
528-102 x Katahdin	65.0	33.2
K 35-6 x 528-274	31.6	24.4
627-618 x Ostragis	51.6	36.2
Sebago x 528-170	78.3	10 6
627-618 x 245-36	20.0	33.0
Menominee x Ostragis	5.0	38.1
Hindenburg x Katahdin (1)	76.6	20.5
Hindenburg x Katahdin (2)	63.3	32.3
528-274 x 627-218	45.0	17.7
125-4 (U.S.D.A.)	28.5	32.6
24-3 (U.S.D.A.)	35.0	30.8
627-49 (U.S.D.A.)	18.6	31.9
529-2 (U.S.D.A.)	35.0	40.0
520-11 (U.S.D.A.)	48.0	100.0
627-126 (U.S.D.A.)	51.6	11.4
53-11 (U.S.D.A.)	16.6	28.0
Maine-Leaf roll resistant	60.0	27.0
Menominee	45.0	52.8
Pontiac	33.3	18.5
Erie	43.3	23.9
Russet Rural	61.6	29.2
Katahdin	5.8	23.5
Sebago	6.6	52.5
Russet Burbank	55.0	46.0
Irish Cobbler	51.6	32.6
White Rural	40.0	39.8
Green Mountain	15.0	64.8
Chippewa	30.0	31.8
Sequoia	20.0	23.1
Kennebec	61.6	23.5
Teton	48.2	9.2
Bliss Triumph	71.6	28.0
Russet Rural x Ostragis	66.3	25.2
245-36 x (Hindenburg x 4-34-1-1)	45.0	66.6

Because of lack of sufficient seed and also inoculum, only one row of 60 hills of each variety was planted.

In making readings on the tubers, it was found that in many cases the only sign of infection was a lead-colored discoloration at the stem end. However, on clipping the stem end of the tuber, there usually was the typical yellow-brown discoloration of the flesh adjacent to the vascular ring and a darker browning of the vascular ring extending deeply into the tuber.

From these tests of only one year, but under conditions very favorable for development of the disease, certain varieties showed considerable ability to withstand infection. This may be resistance or in certain cases only disease escape. The results however give an indi-

cation of the comparative reaction of the varieties under field conditions of heavy soil infestation with *Fusarium eumartii.* Such areas are present in the state and under these conditions the results should indicate to the grower what may be expected of certain commercial varieties.

If reaction to tuber infection is classified into grades of 10 percent intervals, then the Teton variety is outstanding in freedom from disease. Varieties falling into grades of 11 to 20 percent include the unnamed seedling selections from crosses Sebago X 528-170, 627-618X Ostragis, Hindenburg X Katahdin, 528-274X627-218, 627-126 (U.S.D.A.) and Pontiac. Most of the unnamed seedling selections fall into the groups showing 21 to 40 percent infection, while a few are found within the grades 41 to 60 percent.

These results indicate that considerable progress in control of the wilt disease may be made by breeding and, where feasible, similar and more extensive tests should be carried on in connection with those for resistance to scab and other diseases.

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A MODIFIED WET AND DRY-BULB THERMOMETER TECHNIQUE FOR DETERMINING THE MOISTURE CONTENT OR STORAGE QUALITIES OF SO-CALLED DRY MATERIALS

By S. T. DEXTER
SECTION OF FARM CROPS

GRAINS, HAY and other perishable materials heat, mold and spoil readily if stored at too high a moisture content. Although this critical moisture content varies considerably with the material in question, the relative humidity of the surrounding atmosphere at which molding will readily occur seems to be a rather constant value, about 80 percent. Thus, damp grain does not mold if surrounded by dry air. But damp grain will bring the storage atmosphere very quickly to a high relative humidity if there is no ventilation; drier grain will bring it to a lower relative humidity, while very dry grain may even take moisture out of the air. Molding occurs only when the air in the storage compartment reaches a high relative humidity. This paper describes a method by means of which we are able to determine the relative humidity that a sample will build up in storage, with the use of a small sample.

In a series of papers (1), (2), (3), (4), and others, it has previously been shown that:

1. Most common "dry" materials, such as grain, hay, tobacco, paper, and wood, will come to definite moisture equilibria in air at various relative humidities.

2. There is likely to be considerable difference in the moisture contents of these various materials even though they are stored together in the same container, at any given relative humidity. Materials similar in composition are usually similar in moisture-equilibria relationships.

3. The air surrounding a quantity of any one of these materials in a closed container will, on shaking the container, come promptly to

ARTICLE 31-31

a relative humidity closely approximating the air-material equilibrium point. A negligible amount of moisture needs to be evaporated if the air is drier, or absorbed if the air is more humid than the equilibrium value.

4. Molds develop freely at ordinary temperatures in a relative humidity of 80-85 percent or higher.

5. Thus, to determine the keeping qualities, we have but to find the relative humidity of the air surrounding the sample (6).

6. The relative humidity that a saturated aqueous solution of any material such as a salt will establish or maintain in a closed container is a fixed figure, dependent upon the solubility, etc., of the salt. With common salt, sodium chloride, in saturated solution, this figure is 75-76 percent relative humidity (R.H.), with saturated calcium chloride solution giving 32 percent R.H. Thus, a saturated solution of common salt will not give off moisture in air at 80 percent R.H., nor calcium chloride at 50 percent R.H., but will, rather, take up moisture from the air at these respective humidities.

For many reasons, the ordinary devices used in determining relative humidity have not been found useful with small samples, although Gaus *et al.* (6) have reported a method useful with baled cotton. These devices generally require too much air, are slow to come to equilibrium, or readily lose their calibration. Two methods, previously reported, show how moisture contents can be estimated, by colorometric (5) or textural (3) appearances of certain chemicals.

THE MODIFIED WET AND DRY-BULB THERMOMETER METHOD

In the ordinary method of determining relative humidity by the wet and dry-bulb thermometer method, the wet bulb is moistened with water, which evaporates until the temperature of the bulb is reduced to such a temperature that the vapor pressure of the water cooled by evaporation on the bulb is the same as that of the atmosphere, and no more evaporation can take place. For example, in a room at 70° F. and 75 percent R.H., the wet bulb would read approximately 64.5° F., a cooling of about 6°. *At any temperature, and 75 percent relative humidity, a bulb moistened with saturated common salt solution would show no evaporation at all,* and no cooling.

If the dry and the wet bulbs were shaken up with wheat grain at about 15-percent moisture (which maintains a relative humidity of about 75 percent) they would show almost identical readings if the wet bulb were moistened with a saturated common salt solution. If the grain were at 14-percent moisture, the wet bulb would be cooled by evaporation; if the grain were at 16-percent moisture, the wet bulb would become heated above the temperature of the dry bulb. If there is only *slight* evaporation from the wet bulb, the relatively bulky sample of grain, with a relatively great surface, will be able to absorb the water vapor without difficulty, keeping the air at a (practically) constant relative humidity. Or if there is only *slight* absorption of water from the air by the wet bulb, the grain will be able to supply this small amount of water by evaporation and keep the humidity constant.

SELECTION OF THE APPROPRIATE SATURATED SOLUTION

Thus, a solution is selected for moistening the wet bulb that is suited to the range of humidities and moistures being tested, so that, in whatever case, only *slight* evaporation or absorption of water vapor will be required. For example, in the range around 15-percent moisture in wheat, sodium chloride is appropriate, for the highest accuracy and greatest convenience. At a value near 18-percent moisture, potassium chromate would be suitable, since it will maintain a relative humidity of 88 percent. Cupric chloride, 68 percent R.H. at equilibrium, would be excellent in ranges slightly below 13 percent, while magnesium chloride gives equilibrium at 32 percent R.H., and no cooling of the bulb in wheat at 9-percent moisture. At extremely dry ranges, zinc chloride gave no depression at 3.6-percent moisture in wheat. The chemical selected should, in each case, possess the characteristic of maintaining a constant relative humidity over a considerable range of temperature, as well as a relative humidity in the desired range. The ones enumerated are exceptionally well suited in this regard. Manganous chloride, about 54 percent R.H. and barium chloride, about 91 percent R.H., may also be mentioned as being especially constant. For further information see the International Critical Tables and, briefly, page 1397 in Lange's Handbook of Chemistry, 6th edition.

EXPERIMENTAL METHOD

Two thermometers, (range: 10 - 110° C.) were inserted in a large two-hole rubber stopper. On the bulb of one was placed a tight cloth bag, made of two layers of cheesecloth. This cloth was moistened with the solution. The dry-bulb thermometer extended about 4 inches through the stopper, and the wet bulb about 2 inches, to avoid any possible interference. The container was, usually, a 1000-cc. flask or a quart bottle, well wrapped with paper to avoid temperature disturbances on handling. With whole grain, the sample filled the container from one-third to one-half, thus allowing for easy shaking. About 300 grams of wheat, or 200 grams of oats was used. With materials with greater surface, such as sugarbeet pulp, or ground grains, or sawdust, samples as small as 50 grams were found to give the same temperatures as did larger samples.

Before inserting the thermometers into the bottle, the wet bulb was warmed with the fingers to approximately the temperature of the dry bulb. With the thermometers and stopper in place, the bottle was vigorously shaken for about 30 seconds, when a reading of the wet bulb was taken; additional readings were taken until the temperatures were constant. Usually a constant temperature was reached before 90 seconds of shaking had elapsed. If shaking must be continued for more than 2 minutes to obtain a constant temperature, it is likely that the sample is outside the best range of the solution being used. Although during these experiments, depressions or elevations of the temperatures of the wet bulb as great as 5 or 6° were obtained, and could be reliably duplicated, it seems desirable in practice, to avoid this excessive evaporation from the bulb or from the sample, since a more appropriate solution can conveniently be used.

Experimental Data

EXPERIMENT 1

Four saturated solutions, barium chloride, 91 percent R.H., ammonium chloride, 79 percent R.H., sodium chloride, 76 percent R.H., and potassium thiocyanate, 47 percent R.H., were made. Six lots of 300 grams each of wheat grain were mixed with 0, 3, 6, 9, 12 and 15 grams of water, respectively, and shaken repeatedly over a period of 10 days. These samples ranged from 11.20 percent to 15.37-percent moisture.*

*All moisture determinations were made by the Agricultural Chemistry Department after wet and dry bulb determinations were complete; 48 hours at 106° C. in an oven.

In the air in the laboratory, the wet bulb readings were approximately:

Water 17.4° C., barium chloride 19.0° C., ammonium chloride 20.5° C., sodium chloride 20.7° C., potassium thiocyanate 25.2° C., thus indicating successively less evaporation and less cooling, as would be expected.

When shaken with the six lots of wheat, in every case the same order resulted. These lots of wheat were used at four room temperatures, from about 30° C. down to 10° C. (86° F. to 50° F.), with essentially identical results. It should be remarked, however, that samples cannot be taken from one temperature and run immediately at another. For example, a cold sample in a burlap bag taken into a warm room was found to suffer condensation of moisture on its surface, and to give high-moisture-content readings. The bottle should be at the same temperature as the sample. Otherwise, it is impossible to arrive at a constant dry temperature reading of the air, and, if the bottle is cold, condensation on or in the bottle is likely to occur. Table 1 shows the results with the four chemicals.

TABLE 1—*The difference in temperature, Temperature of dry bulb (T_d) — Temperature of wet bulb (T_w), is given below for the six samples of wheat at the moisture contents shown. Results with the four saturated solutions indicated are given. If $T_d - T_w$ is positive, T_w is cooler than T_d. Negative values indicate heating of the wet bulb. For example, the top value for Barium Chloride is 29.5° C. — 23.7° C. = 5.8° C. The bottom value for potassium thiocyanate is 29.5° C. — 32.7° C. = —3.2° C. (the wet bulb heated)*

Moisture* in sample %	Td—Tw using the saturated solution on wet bulb						
	Barium chloride	Ammonium chloride	Sodium chloride				Potassium thiocyanate
	Td 29.5° C.	29.5° C.	29.5° C.	24.8° C.	22.5° C.	11.0° C.	29.5° C.
	Td—Tw	Td—Tw	Td—Tw	Td—Tw	Td—Tw	Td—Tw	Td—Tw
11.20........	5.8	3.5	3.2	3.4	3.4	2.9	1.0
12.17........	4.8	2.5	2.2	2.2	2.2	2.0	0.2
13.26........	4.1	1.5	1.3	1.3	1.2	1.0	−0.4
13.67........	3.5	0.8	0.6	0.6	0.7	0.6	−1.6
14.90........	2.5	0.1	0.0	0.0	0.2	0.0	−2.5
15.37........	2.1	−0.2	−0.4	−0.4	−0.3	−0.5	−3.2

*These samples were used for many tests, and moisture contents certainly changed somewhat in this extensive handling. These moisture determinations were made after the conclusion of the Td—Tw tests.

EXPERIMENT 2

Six lots of oats, six of barley, were run with saturated sodium chloride on the wet bulb. Table 2 shows these results.

TABLE 2—*Difference in bulb temperatures, $T_d - T_w$, is given for oats and barley and sugarbeet pulp samples with saturated sodium chloride solution on the bulb. Negative values show heating of the wet bulb*

Oat samples		Barley samples				Sugarbeet pulp	
Moisture percent	Td - Tw	Moisture percent	Td 24° C. Td - Tw	27.5° C. Td - Tw	25.7° C. Td - Tw	Moisture percent	Td - Tw
11.27......	3.0	9.22.....	4.6	4.9	4.8	10.00.....	2.2
11.94......	1.5	10.34.....	3.6	3.9	3.7	12.0....	1.2
13.05......	0.5	11.00.....	2.6	2.8	2.9	13.5.....	0.6
13.64......	0.0	11.85.....	1.8	1.9	2.0	15.2.....	0.0
14.66......	−0.5	12.77.....	1.1	1.0	1.2	....	....
15.63......	−1.0	13.82.....	0.4	0.4	0.5		

EXPERIMENT 3

Four presumably identical replicates A, B, C, and D, were made of samples of wheat at 5 moisture contents. These four identical samples were run, using four different solutions: a) potassium chromate, b) sodium chloride, c) cupric chloride, and d) magnesium chloride. Table 3 shows the results. Since the chemical determinations of moisture on these samples varied by several tenths of one percent in several cases, the average of the four replicates is used.

TABLE 3—*$T_d - T_w$ is given on 20 samples of wheat, five with each of the four chemicals shown*

Average moisture, four samples, percent	Saturated solution used on the wet bulb			
	Potassium chromate Td - Tw	Sodium chloride Td - Tw	Cupric chloride Td - Tw	Magnesium chloride Td - Tw
9.03........................	6.3	5.3	3.7	0.0
10.50........................	5.1	3.8	3.1	−1.4
12.01........................	3.4	2.4	1.6	−2.9
13.18........................	2 2	1.2	0.6	−4.8
14.46........................	1.4	0.3	−0.5	−6.2

EXPERIMENT 4

In order to determine whether or not grinding a sample made any difference in the values obtained, a large number of samples were run, both before and after coarse grinding. Table 4 shows the results. Grinding permitted the use of a smaller sample but otherwise had little effect.

TABLE 4—*Values of $T_d - T_w$ obtained with whole versus coarsely ground grain are shown for wheat, dent corn and white beans. Saturated sodium chloride solution was used on the wet bulb*

Wheat			Yellow dent corn			White beans		
Moisture percent	Whole Td - Tw	Ground Td - Tw	Moisture percent	Whole Td - Tw	Ground Td - Tw	Moisture percent	Whole Td - Tw	Ground Td - Tw
9.8	4.8	4.6	10.8	3.8	3.9	12.3	1.8	1.9
10.5	3.5	3.7	13.4	1.1	1.4	15.0	0.7	0.7
11.1	2.9	3.1	14.1	0.8	0.8	15.7	0.5	0.5
11.8	2.1	2.3	14.7	0.4	0.4	17.2	0.3	0.3
12.5	1.5	1.6	18.3	−1.5	−1.5	18.2	0.5	0.5
13.2	1.2	1.4	19.5	−1.7	−1.7			
			22.4	−2.4	−2.4			

EXPERIMENT 5

It was the intention, in previous experiments, to have the individual samples reasonably uniform and to accomplish that end, they were stored for several days before testing in closed flasks. In this experiment, five lots of wheat were used, ranging from 9.03 to 14.46 percent moisture, and samples were made by mixing, in equal amounts of wheat from every possible pair of samples. Table 5 shows the results. In every case, the temperature value obtained is intermediate between the values of the two components.

TABLE 5—*Five lots of wheat and five different moisture contents were prepared. Every possible mixture of these lots, in two equal parts was made and the $T_d - T_w$ determined at once. The values are given below. Sodium chloride solution on the wet bulb*

Sample number	1 Td - Tw	2 Td - Tw	3 Td - Tw	4 Td - Tw	5 Td - Tw
1	5.8*	4.8	3.5	2.9	2.1
2	4.8	3.8*	3.0	2.1	1.5
3	3.5	3.0	2.4*	1.8	1.2
4	2.9	2.1	1.8	1.2*	0.6
5	2.1	1.5	1.2	0.6	0.3*

*Td - Tw for the original samples.

EXPERIMENT 6

To determine whether very slight differences in moisture content might be detected, three samples of wheat grain were prepared by adding 0.0, 0.3 and 0.6 gram of water to 300 grams of wheat. This would give moisture differences of approximately 0.1 and 0.2 percent. These samples were repeatedly tested, with the wet and dry-bulb technique and finally the samples were analyzed by the chemists, when a total difference of 0.38 percent in moisture content was found.

The differences in wet-bulb depressions, or elevations, were from a minimum of 0.25° to a maximum of 0.6°, but the samples never varied in order. A discrepancy of this magnitude could easily occur from error in reading the dry-bulb thermometer.

EXPERIMENT 7

The previous experiments have been directly related to the common grains, wheat, oats, barley, corn and beans. In the manufacture and handling of these, and similar products, the necessity for moisture determinations frequently arises, and in many cases, variations of relatively slight magnitude are of great importance.

Sugarbeet pulp, for example, must be dried before shipping. Four samples were prepared by adding 0, 2, 4, and 6 grams of water to 100 grams of dried pulp. With sodium chloride on the wet bulb, the temperatures were read the same day as mixing, and the next day. Table 2 shows the temperature depressions, and the percentages of moisture.

Many cereal products are on the market. Their acceptability to the public is greatly influenced by their moisture content. Thus, fresh and stale crackers, crisp and tough breakfast foods may be distin guished merely by a slight change in moisture content. Table 6 indicates that these qualities are readily detected by the wet and dry-bulb technique, using appropriate solutions. Such examples might be enumerated indefinitely in the field of industry, where routine moisture determinations are necessary on dry materials that come to a moisture equilibrium with the atmosphere.

TABLE 6—*Breakfast foods and other very dry materials may be tested for moisture content by moistening the wet bulb with saturated solutions of magnesium chloride, zinc chloride or with other solutions with low aqueous vapor pressures.* $T_d - T_w$ *for materials in various conditions of dryness are shown below*

Moisture percent	Saturated solution used: Magnesium chloride Td - Tw	Saturated solution used: Zinc chloride Td - Tw	Remarks
4.93	1.2	−2.0	Fresh soda crackers
8.01	−1.3	—	Somewhat tough crackers
4.66	1.0	—	Fresh breakfast food
5.61	−0.6	—	Acceptable breakfast food
11.46	−4.5	—	Tough breakfast food
3.58	4.2	0.0	Very dry wheat grain

DISCUSSION

Many of these samples were retained for a period of several weeks, with repeated determinations on the same samples. The depression or elevation of the wet-bulb temperature was almost perfectly reproduced on successive days, even though the temperature of the room may have changed appreciably, and the sample become more uniform.

The size of sample is directly related to the applicability of this method. The sample will be found to have a rather definite limit in ability to absorb moisture, and maintain the relative humidity at a fixed point. For example, if a sample of wheat with 11-percent moisture is run with sodium chloride solution on the wet bulb, a depression of about 3.2° C. would be obtained. If this sample is permitted to stand for 2 or 3 minutes and the determination repeated, the cooling may amount to no more than 2°. However, if the sample is permitted to stand for 30 minutes, the original value of 3.2° is obtained, as it is on successive days. The evaporation, while very slight, is nevertheless appreciable, with large depressions in temperature. If the depressions are small, evaporation is slight, and the sample will give agreeing values even if rerun at once. Even when evaporation is sufficient to give substantial cooling, the wet bulb does not dry enough to be observable to the operator. A series of six samples or more was frequently run, without being able to detect any drying of the bulb even though it undoubtedly occurred. In the same way, when heating of the bulb as much as 6° C. occurred, as with magnesium chloride on the bulb in 14.5-percent moisture wheat, no condensation was superficially evident. As previously explained, such extreme cooling or heating of the bulb is unnecessary and is felt to be inadvisable, since an appropriate solution can be used, in which large deviations of the wet-bulb temperature will not occur.

It is obvious that a thermometer with a small bulb, and low thermal capacity, as well as a small cloth wick is desirable, particularly when samples with low absorbing capacity are used. Thermometers used in this experiment were ordinary chemical laboratory thermometers, graduated in degrees. It was necessary to use a hand reading-glass to estimate accurately to tenths of a degree. For very accurate work, special thermometers or equipment with low thermal capacity would be helpful.

It has repeatedly been shown that the moisture content at equilibrium with any given relative humidity will vary somewhat in different

lots of wheat, lumber, etc. Since the wheats vary in chemical composition, this variation is to be expected. However, since in a great many cases, we are more interested in their characteristics of taking up or losing water than we are in their actual moisture content, this increases rather than decreases the value of the test. And since spoilage seems to be far more closely related to relative humidity of the atmosphere than to the actual moisture content of the material, in many cases the test is definitely more informative in regard to storage characteristics than a moisture-content analysis can be.

THEORY

One brief example, relating to the theory of the test will be given. Three samples, A, B, C, of white beans were tested with sodium chloride on the wet bulb. They gave a heating of (A) 0.7° C., a heating of (B) 0.3° C., and a cooling of (C) 0.6° C. of the bulb. Samples A and B, therefore, seem to give a relative humidity in the closed container somewhat above the relative humidity given by saturated sodium chloride solution, and therefore moisture condenses on the bulb and heats it. Sample C gives a relative humidity slightly less than that of saturated sodium chloride solution, and consequently there is slight evaporation and cooling. Small weighed samples of these three lots of beans were placed in relative humidity chambers of 70-, 75-, and 80-percent relative humidity respectively for 2 days, and then reweighed, and the weights computed as 100 percent of the original weight. Table 7 shows the results. We would expect samples A and

TABLE 7—*White beans at the moisture contents shown were exposed for 2 days in air at relative humidities of 70%, 75% and 80%. If 100 is the original weight of the beans, the values given show the weights after exposure. Sodium chloride was used on the wet bulb*

Moisture percent	Td - Tw	Relative weights after exposure at		
		70 percent R.H.	75 percent R.H.	80 percent R.H.
15.65	0.5	99.52	100.83	102.65
17.19	0.4	97.66	99.06	100.74
18.21	0.7	96.55	98.02	99.71

B to dry out appreciably at 70-percent R.H., and sample C only slightly or perhaps not at all. At 75-percent relative humidity, we would expect less evaporation from samples A and B and absorption of water by C. At 80-percent relative humidity, we would expect

slight evaporation by sample A, and perhaps slight absorption by sample B. Sample C should absorb appreciably. All of this is precisely what occurred.

The mathematics of the vapor pressures of solutions and of adsorbed water is not appropriate to this paper. It is sufficient to say that the magnitude of the differences in wet-bulb temperatures at any given relative humidity between water and saturated sodium chloride solution increase as the temperature of the dry bulb increases. Another complication arises in the fact that grains, etc., will hold in equilibrium a somewhat higher percentage of moisture at a low than at a higher temperature at any given relative humidity. In either case, the differences are relatively small, but are sufficient so that *a more or less standard temperature for testing is recommended,* particularly for very accurate work. Generally speaking, a variation of 10° F. one way or the other on the dry bulb will give variations in the difference between wet and dry-bulb temperatures, on any sample, of little more than 0.1°, for the small depressions or elevations advised.

The amount of water required to bring a quart of air from 50 to 75-percent relative humidity is exceedingly small. Such an amount of evaporation from a 300-gram sample of wheat would change its moisture content approximately 1/1,000 of 1 percent. Similarly, the total quantity of evaporation required from a wet bulb to cool it 1 degree is very small, amounting to approximately the same quantity of water.

It is evident from the explanations above that samples wet with dew or other surface moisture will give relative humidities higher than they will after this moisture has had a chance to soak in. Correspondingly, it would perhaps be possible to prepare a grain sample by heating in an oven, on which a dry surface film would give a relative humidity lower than it would give after standing for an interval. These precautions and those previously described as to temperature should be kept in mind and observed to give accurate results with this method.

SUMMARY

A method has been described by means of which the moisture content and storage quality of dry products may be determined. The method uses two thermometers, one with a wet bulb on which is used not water but a saturated solution of a suitable chemical. The object is to use a solution from which there will be only very slight

evaporation at the relative humidity maintained by the sample in a closed container. For farm grains, a saturated solution of sodium chloride is suitable for the wet bulb since it will evaporate only at relative humidities lower than 75 percent (about 15-percent moisture in wheat). For drier materials, other solutions such as magnesium chloride may be used. For somewhat higher relative humidities, potassium chromate or barium chloride solutions are useful. In each case, the heating or the cooling of the wet bulb should be small, for greatest accuracy.

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FEEDING AND CONFINEMENT REARING EXPERIMENT WITH TURKEYS—ELEVENTH SERIES

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SECTION OF POULTRY HUSBANDRY AND LAKE CITY EXPERIMENT STATION

THIS REPORT is the eleventh of a series of studies on increasing turkey production efficiency. Confinement rearing methods are employed because they make possible a better control of the factors of production and are most exacting in their demands for perfectness of diet and general biological understanding.

These studies were started in 1935, and each year the same brooding, rearing and management methods are strictly adhered to in order to prevent, insofar as possible, the injection of environmental or management factors which in themselves might influence the results. The same strain of Standard Bronze turkeys is used each year to represent this breed and to serve also as a check group for comparing the results with turkeys of other breeding.

Earlier trials resulted in the development of several efficient mash formulas, of which mash 7 has proved to be an excellent all-purpose mash. This mash, with its later accompaniment of grain, is adequate for normal growth and excellent development of turkeys reared under confinement conditions. Since 1936, mash 7 has been included each year in combination with yellow corn as a standard check ration with which the results of other feed combinations are compared. The annual experiments, thus, have a close relationship to each other because the basic conditions and manner of presenting data are comparable.

When deemed of sufficient importance, certain of the feeding trials and trials with turkeys of different breeding are repeated for more than one year to check possible seasonal variations and the consistency of results. Turkeys of different breeding are commonly tried with more than one feed combination, or perhaps with a trial on a cobblestone yard as compared with the usual experimental turkey house.

ARTICLE 31-32

The importance of repeated trials and the usefulness of such data have become increasingly apparent as these studies have progressed.

GENERAL OBSERVATIONS

One may discern certain significant trends in considering the results of 119 separate feeding trials (1935-45) involving 3,052 turkeys of several types and varieties, and a number of different mash and grain combinations fed on a free-choice basis under confinement conditions. The data cover a period of 11 years during which time, as previously mentioned, special emphasis was placed on keeping management and environmental factors on a uniform basis. These observations are especially directed at factors having a bearing on turkey production efficiency.

Consistency of Repeated Trials

Repeated trials under controlled conditions have tended to reveal quite definite characteristics for each mash, each grain, or their combination, which may not be correctly indicated by a single trial. It is also of interest to note that these characteristics tend to be repeated with a reasonable consistency from year to year so that in a sense they become predictable. Thus, in 1938, a six-trial average (1935-37), which used Standard Bronze turkeys fed mash 7 with yellow corn as the grain on a free-choice basis, revealed that the turkeys consumed an average of 3.06 pounds of mash and 1.28 pounds of corn (a total of 4.34 pounds of feed) per pound of gain to 24 weeks of age. This is a mash-to-grain ratio of 70.5 to 29.5. A 10-trial average taken in 1938 gave substantially the same figures. The addition of 12 subsequent trials to the earlier figures for the present 18-trial average (1935-43) gives the remarkably close figures of 3.05 pounds of mash and 1.34 pounds of corn (4.39 pounds of total feed) a 69.5 to 30.5 mash-to-grain ratio. In 12 of these 18 trials the deviation from the average total feed consumed is not over 0.1 pound, with a maximum of 0.32 pound. Mash showed slightly greater variability in seven trials, having a deviation of not over 0.1 pound; in 16 with less than 0.38 pound, and in one instance with 0.7 pound. Although the grain part of the ration tends to fluctuate with mash variations to approximate the average total feed consumed, a difference from the average of 0.7 pound in mash consumption per pound of gain is not typical

and could result in a difference of from 2 to 3 cents per pound in production costs. These figures are based on the accumulated results with the standard check ration which is repeated each year.

Importance of Oats in the Ration

The grain studies, which were started in 1938, have proved to be a promising field for exploration. The grain trials quickly revealed the importance of whole oats in the ration for growing turkeys and the consistent tendency for this grain to bring about a substantial reduction in the amount of mash required per pound of gain and also in the cost of such gains. Standard Bronze turkeys in six trials (1940-44), with mash 7 and both corn and oats, consumed an average of only 2.16 pounds of mash per pound of gain or 0.89 pound less mash than when corn was the only grain (18-trial average, 1935-43). The total amount of grain consumed in these trials was increased only 1.09 pounds. The inclusion of oats changed the mash-to-grain ratio from 69.5:30.5 to the relatively low ratio of 46.76:57.24. This understanding of the value of oats in the ration has made possible the production of turkeys on approximately 30-percent less mash than formerly and at an expected reduction in production costs. The current work with other grains and mashes and also different grain and mash combinations suggests a number of interesting possibilities for increasing turkey production efficiency.

Factors Influencing Total Feed Per Pound of Gain

The type of turkey used seems to have a greater influence on the total pounds of feed consumed per pound of gain than any other single factor. Large-type turkeys tend to consume slightly less and small-type turkeys slightly more total feed per pound of gain to 24 weeks of age than turkeys of intermediate type. This tendency is remarkably consistent. In 28 trials, in which direct comparisons were made between turkeys of these different types, there was no exception to this trend; so, in a sense, it is predictable. The range of difference, between small and medium as well as between medium and large-type turkeys, quite typically has been from 0.2 to 0.4 pound when results were computed to 24 weeks of age. In these comparisons the Beltsville Small White variety is considered to represent the small type, Standard Bronze the medium, and Broad Breasted Bronze the large type. The protein content of the mash and the kind of grains used also seem to have some influence on total amount of feed consumed but are less consistent in this respect than the type of turkey used.

In only four instances in 119 trials did turkeys produce gains on less than 4 pounds of total feed, as an average, to 24 weeks of age. Two of these low-feed totals were in 1944 when one Standard Bronze and one Broad Breasted Bronze pen produced gains on 3.74 and 3.85 pounds of feed, respectively. Each pen was fed a growing mash of 25.44-percent protein content. For grain, the Standard Bronze pen had wheat, and the Broad Breasted Bronze, wheat and oats to 20 weeks of age. The grain was yellow corn after 20 weeks in both instances. In 1945, two Broad Breasted Bronze pens, fed growing mashes of 27.31- and 30.13-percent protein, with corn and oats to 20 weeks and corn only after that time, consumed 3.81 and 3.78 pounds of feed per pound of gain. In each of those years, these low-total-feed pens were the lowest in cost.

Gains have been made on less than 4.2 pounds of feed by eight additional pens, and all of these birds were on growing mashes ranging from 25- to 30.13-percent protein. Four of these pens received only yellow corn as grain; two pens had corn and oats; and two pens were provided with wheat, oats, and corn. With mashes below 25-percent protein, the lowest amount of feed consumed was 4.2 pounds with a pen of Standard Bronze turkeys fed a 23-percent growing mash and corn, in 1936.

Desirability of Low-Mash Consumption Per Pound of Gain

Low-mash consumption is usually associated with low feed cost per pound of gain. The amount of mash which turkeys will choose to consume is strongly influenced by both the protein content of the mash and the kind of grain fed, and to a less degree, by the type of turkey used. The use of high-protein growing mashes (above 25 percent) and the inclusion of oats as one of the grains are the two most prominent contributors to low-mash consumption.

In the 119 trials considered, the amount of mash consumed per pound of gain ranged from 3.91 to 1.61 pounds. In only 13 trials did turkeys consume less than 2 pounds of mash per pound of gain, as an average, to 24 weeks of age. In 11 of these instances the protein content of the mash exceeded 25 percent, and in only two trials was it below this percentage. Oats were one of the grains in all instances.

In 18 trials in which Standard Bronze turkeys were given mash 7 (27-percent protein) and only corn as the grain, the turkeys consumed an average of 3.05 pounds of the mash. When oats were also

included with the foregoing combination in six additional trials, the turkeys consumed an average of only 2.16 pounds of mash. In 15 trials in which Standard Bronze turkeys were given lower protein growing mashes, ranging from 22- to 24.9-percent protein content, and only corn as the grain, the turkeys consumed an average of 3.42 pounds of the mash per pound of gain. When oats were also included in five additional trials, the average amount of mash consumed was reduced to 2.4 pounds. The inclusion of oats, in these instances, resulted in a reduction of the amount of mash consumed by approximately 30 percent, this reduction being 29.8 and 29.2 percent, respectively. Thus, while the higher protein growing mashes characteristically produce gains with a lower mash consumption than mashes of lower protein content, the percentage reduction in mash consumption resulting from the inclusion of oats is approximately the same in each case.

Desirable Mash-to-Grain Ratio

In considering the efficiency of a given feed combination or of a certain type of turkey, the percentage of the total feed consumed in the form of mash and of grain also should be noted. Because the cost of grain is usually not over 60 to 70 percent of the mash cost, it is obvious that a combination of factors that would result in the consumption of a relatively low percentage of the total feed as mash and a relatively high percentage as grain would be desirable, providing the total amount of feed consumed is not materially increased. It is commonly observed that when the amount of mash per pound of gain is reduced, the amount of grain consumed tends to increase slightly more than the mash reduction. This usually results in a slight rise in the total feed consumed. The final result, however, is that the cost of gain tends to be lowered. The two most important factors that contribute to a relatively low mash percentage are the inclusion of oats as one of the grains, with either corn or wheat, and the use of mashes of relatively high-protein content.

In 119 trials (1935-45) with several types of turkeys and with various mash and grain combinations under a free-choice system of feeding, the percentage of the total feed consumed in the form of mash ranged from a high of 84.3 to a low of 30.4 percent. In the first instance, the turkeys consumed only 15.7 percent of their total feed in the form of grain, and in the latter instance 69.6 percent grain. In 39 of these trials in which Standard Bronze turkeys were fed only corn as the grain but with several different mashes, the turkeys consumed

3.23 pounds (72.72 percent) of mash, 1.21 pounds (17.28 percent) of grain and 4.44 pounds of total feed, as an average, per pound of gain to 24 weeks of age. With 22 additional trials (1938-45) under similar conditions but with whole oats included with the corn for the grain part of the ration, the turkeys consumed only 2.13 pounds of mash (46.60 percent) and 2.44 pounds (53.40 percent) of grain and 4.57 pounds of total feed per pound of gain. In other words, with the inclusion of oats and with mashes of possibly slightly higher protein content, it was possible to utilize 1.23 pounds of the cheaper grain to replace 1.10 pounds of the more expensive mash for each pound of gain produced. This ability to replace a substantial part of the more costly mash with cheaper grain has proved an important means for the lowering of feeding costs.

In only six instances, in these trials, were turkeys reared to 24 weeks of age with mash constituting less than 40 percent of their total feed. In those cases, the proportion of mash consumed ranged from 30.4 to 38.4 percent. All received oats, with either corn or wheat, or with both corn or wheat, as whole grain. In five of the six instances the growing mash exceeded 25 percent, and with three of these the mash was above 29-percent protein content. In only one instance was the growing mash below 25 percent. The final weights of both males and females in this group were included generally in the heavier 30-percent for the particular year. In four of the six instances, the cost per pound of gain was the lowest for the particular breed and year and was associated with mashes of the higher protein levels. The highest cost for this group was with the low-protein growing mash having a protein content of 22.75 percent, and this ranked sixth in cost in seven comparable trials for the particular year.

Thus it seems that the percentage of the total feed which turkeys will consume in the form of mash tends to be definitely and materially reduced by the inclusion of whole oats as one of the grains and also by the use of growing mashes of relatively high protein content.

Factors Influencing Final Weights

Relatively heavy final weights are desirable because they are usually associated with rapid and economical gains and superior market quality. The protein content of the growing mash seems to have a greater influence, both on the rate of growth and the final weight than the kind of grain fed. Growing mashes of relatively high

protein content (26- to 32-percent) tend to result in heavier final weights, and usually at lower cost per pound of gain, than mashes of lower (19- to 25-percent) protein levels.

In only 20 instances in 79 trials (1935-45) with Standard Bronze turkeys did the average weight of males at 24 weeks of age exceed 19 pounds. The growing mashes in all of these instances were above 26-percent protein content and ranged to a high of 31 percent. In no trial to date has this variety and strain of turkey produced an average male weight above 19 pounds at 24 weeks of age on growing mashes of less than 26-percent protein content. In only 19 instances in these 79 trials has the average weight of female turkeys at 24 weeks of age been above 13 pounds. In 16 of these 19 trials the protein content of the growing mash was above 26 percent, and in only three instances was the protein content below this figure. The grains used in these trials included corn, corn and oats, and a four-grain offering of corn, wheat, oats, and barley. All of these grains or grain combinations gave excellent results as to final weights when fed with growing mashes of relatively high protein content. Birds which received the corn and oats and the four-grain offering consumed an average of 54.7 and 54.5 percent, respectively, of their total feed in the form of grain; while those which received only corn consumed an average of only 31.5 percent of their total feed as grain.

In eight trials (1940-45), using a 27-percent growing mash and in which direct comparisons were made between corn and oats and corn as the only grain, the average weight of males receiving corn and oats was 0.88 pound heavier and females 0.47 pound heavier than for turkeys receiving corn as a single grain.

Birds in the feeding trials which resulted in relatively heavy final weights also showed a remarkable consistency for being included among the lowest in cost per pound of gain for the particular variety and year.

OBJECTIVES OF THE 1945 TRIALS

The 1945 trials included a continuation of studies with turkeys of different types on certain mash and grain combinations to obtain additional data. As already stated, Broad Breasted Bronze turkeys were used to represent the large type, Standard Bronze the intermediate, and Beltsville Small White for the small type. Previous trials indicated that each type of turkey had its own peculiar feeding characteristics

as well as growth characteristic. An example of certain of these type differences is noted in considering 18 separate trials (1939-44) in which small-type turkeys were fed several different mash and grain rations in a free-choice manner in direct comparison with turkeys of the Standard Bronze variety. In every instance in those 18 trials, the small-type turkey consumed slightly more mash and, in 16 of the 18 trials, slightly more total feed per pound of gain than the Standard Bronze. In the 1945 trials, turkeys of the three varieties stated above were fed growing mashes of three different protein levels. Corn and oats were compared with corn only with two different mashes.

Cost and rearing studies were continued with Broad Breasted Bronze, Standard Bronze, and Beltsville Small White turkeys. These three varieties were used with different mash and grain combinations and also in cobblestone yard trials.

Observations were continued on the practicability of using a permanent turkey house and also as to the use of a cobblestone yard for the rearing of market turkeys and to control losses. The data for the three cobblestone yard pens are presented as pens 11, 12, and 13. The mashes used and the feeding plan are given in tables 1 and 1A, respectively. The tables included in this report present the data for the 1945 trials.

TABLE 1—*Rations*

Mash number	7	13
Protein content of mash (percent)	27.31	30.13
Ground yellow corn	10	6
Ground oats	15	15
Wheat bran	10	10
Wheat flour middlings	10	—
Meat scrap	14	12
Fish meal	—	8.5
Dried milk	10	10
Soybean oil meal	22	25
Alfalfa meal (17% dehydrated)	5	10
Calcium carbonate	1	2
Salt	1	1
*Cod liver oil	2	.5
Total	100	100
Manganese sulfate added per ton	8 ounces	8 ounces

*Cod liver oil of 85 vitamin D units was used in ration 7, while a feeding oil of approximately 400 D units was used in ration 13. These feeding oils were discontinued at about the sixteenth week.

TABLE 1A—*Feeding plan**

Pen	Breeding	No. of birds	Hatching date	Mash 0 to 8 weeks	Mash 8 to 26 weeks	Grain 8 to 20 weeks	Grain 20 to 26 weeks
1	Standard Bronze..........	25	April 14	7	7	corn	corn
2	Standard Bronze..........	25	April 14	7	7	corn oats	corn
3	Beltsville Small White......	25	April 14	7	7	corn oats	corn
4	Broad Breasted Bronze.....	25	April 14	7	7	corn oats	corn
5	Standard Bronze..........	25	April 28	7	13	corn	corn
6	Standard Bronze..........	25	April 28	7	13	corn oats	corn
7	Beltsville Small White......	25	April 28	7	13	corn oats	corn
8	Broad Breasted Bronze.....	25	April 28	7	13	corn oats	corn
*9	Beltsville Small White......	25	May 26	7	X**	corn oats	corn
*10	Broad Breasted Bronze.....	25	May 26	7	X**	corn oats	corn
11	Standard Bronze..........	25	May 12	7	13	corn oats	corn
12	Beltsville Small White......	25	May 12	7	13	corn oats	corn
13	Broad Breasted Bronze.....	25	May 12	7	13	corn oats	corn

*Mash was available at all times from the first day to the end of the trials with all pens. Grain as indicated above was added to all diets at the end of the eighth week and was fed in a free-choice manner from then on to the finish. Oats, when included, were gradually reduced after the eighteenth week and were discontinued at the end of the twentieth week.

**Mash X is a commercial growing mash of 21.0-percent protein content which is used rather extensively in this area. This mash is included for comparison with open-formula growing mashes of higher protein content

TABLE 2—*Proportion of mash and grain consumed* (total mash and grain consumed = 100)*

Pen	0–4 Weeks		5–8 Weeks		9–12 Weeks		13–16 Weeks		17–20 Weeks		21–24 Weeks		25–26 Weeks	
	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain
1........	100	0.0	100	0.0	99.5	0.5	98.1	1.9	82.2	17.8	44.0	56.0	31.6	68.4
2........	100	0.0	100	0.0	99.6	0.4	57.8	42.2	48.4	51.6	38.5	61.5	24.8	75.2
3........	100	0.0	100	0.0	92 0	8.0	70.3	29.7	55.6	44.4	51.6	48.4	31.0	69.0
4........	100	0.0	100	0.0	86.4	13.6	72.3	27.7	61.8	38.2	54.4	45.6	38.2	61.8
5........	100	0.0	100	0.0	99.9	0.1	98.3	1.7	74.0	26.0	45.4	54.6	20.2	79.8
6........	100	0.0	100	0.0	59.1	40.9	47.3	52.7	50.8	49.2	32.1	67.9	14.1	85.9
7........	100	0.0	100	0.0	86.8	13.2	63.5	36.5	56.7	43.3	44.3	55.7	26.0	74.0
8........	100	0.0	100	0.0	70.5	29.5	63.3	36.7	54.2	45.8	45.0	55.0	33.3	66.7
9........	100	0.0	100	0.0	97.6	2.4	80.0	20.0	51.2	48.8	37.1	62.9	39.2	60.8
10........	100	0.0	100	0.0	100.0	0.0	73.0	27.0	56.5	43.5	44.3	55.7	13.8	86.7
11........	100	0.0	100	0.0	42.5	57.5	40.2	59.8	38.4	61.6	26.3	73.7	16.4	83.6
12........	100	0.0	100	0.0	62.2	37.8	50.6	49.4	53.5	46.5	40.6	59.4	21.9	78.1
13........	100	0.0	100	0.0	64.2	35.8	55.7	44.3	50.5	49.5	41.0	59.0	24.4	75.6

*Mash in hoppers at all times. Grain in hoppers after the eighth week.

Experimental Pens at East Lansing

The poults used in these trials were hatched from eggs produced by the breeding flocks at the Lake City Experiment Station. The hatching dates for the different pens are given in Table 1A. The newly hatched poults, in lots of about 50, were placed in small pens and provided with shavings for litter and a small brooder. Only mash 7 in hoppers and water in vacuum fountains were given for the first week.

At the end of the first week, the poults were weighed and sorted into experimental lots of 25 each. Each lot was provided with an indoor floor pen, 4½ feet wide and 10 feet long, with an electric hover. Perches were added when the hovers were no longer required.

Because of restricted space in the laboratory, it was necessary to remove each group to quarters in a laying house when they were 4 weeks of age. With each lot, it was necessary to keep the poults under the conditions described until their age and the weather conditions made it possible to transfer them to the large, open-front house at Lake City. This was between 7 and 8 weeks of age for each group.

The Lake City Turkey House

At the Lake City Station, each lot of 25 turkeys (with the exception of yard pens 11, 12, and 13) was confined to a pen 10 feet wide and 24 feet long in the open-front turkey house. This building, which is 100 feet long, is constructed of rough lumber and poles. The house is divided into pens with wire and wood partitions. At the end and back walls are hinged panels that may be opened for ventilation in summer. At the rear of each pen are perches and a dropping board. The floors are of concrete, and chopped straw is used as litter.

The Cobblestone Turkey Yard

Cobblestone yards have provided a relatively simple method of yarding turkeys for the control of Blackhead. The first of these yards was constructed at the Lake City Station in 1936, and others have been added since this time. These are permanent yards, and the ones used primarily for experimental work are approximately 40 by 80 feet in size. Each yard is provided with an inexpensive shelter with roosting quarters. The essential feature of the yard is that the ground is covered to a depth of 6 to 8 inches with field stones that vary in size from about 3 to 6 inches in diameter so that the turkeys do not come

in contact with the soil. Each rain washes off the droppings, and the yard looks clean, even in the summer months when the rains are less frequent. If, in the course of time, the yards need renovating, the stones may be loosened with a spring-tooth harrow and more stones added as needed.

Experimental pens 11, 12, and 13 are reared on these cobblestone yards.

Feeding Plan

A free-choice feeding of corn and oats was used with all pens, except pens 1 and 5 which received only corn as grain, and this was hopper-fed as with the two-grain choice. Grain feeding was started with all pens when the poults were 8 weeks of age. With all corn and oat pens, the oats were gradually reduced in the amount offered after the eighteenth week, and oats were entirely discontinued after the twentieth week, leaving corn as the only grain from then on to the finish. The corn and oats were hopper-fed in an equal and free-choice manner to the 11 pens receiving this two-grain offering. The variety of turkey used as well as the ration is shown in Table 1A which outlines the feeding plan. The birds in house pens 5, 6, 7, and 8 and cobblestone yard pens 11, 12, and 13 received mash 7 until the end of the eighth week, at which time they were changed to mash 13 until the trials were completed. Mash 13 is a concentrate mash, with a protein content of approximately 30 percent, and mashes of this type are expected to bring about the consumption of relatively large amounts of grain. Beltsville and Broad Breasted Bronze turkeys, in pens 9 and 10 respectively, received mash 7 until the end of the eighth week when they were changed to mash X for the remainder of the trials. Mash X is a low-protein commercial mash of approximately 21-percent protein content which is used rather extensively in this region. The turkeys in pens 1, 2, 3, and 4 received mash 7, which has a protein content of approximately 27 percent, for the entire period of these trials.

Rearing and cost studies with Standard Bronze turkeys were conducted with birds in pens 1, 2, 5, 6, and 11; with Beltsville Small White turkeys in pens 3, 7, 9, and 12; and with Broad Breasted Bronze in pens 4, 8, 10, and 13.

Standard Bronze, Beltsville, and Broad Breasted Bronze are comparable under different conditions in pens 2, 3, and 4; 6, 7, and 8; 11, 12, and 13; and also are Beltsville and Broad Breasted Bronze in pens 9 and 10, as the management and diet were the same in each group-

ing. A comparison of housed turkeys and yarded birds on the same ration may be made with Standard Bronze in pens 6 and 11, Beltsville turkeys in pens 7 and 12, and Broad Breasted Bronze in pens 8 and 13, respectively. The results under different conditions, with the three turkey varieties considered, may be observed by examination of the several tables which accompany this report.

CURRENT OBSERVATIONS

Type and Sex Differences with Respect to Maturity

It is commonly known that female turkeys tend to mature at an earlier date than male turkeys, but information is quite limited on differences as to time of maturity that may exist between turkeys of various types. The data of the current trials afford an opportunity to make comparisons between turkeys of small, intermediate, and large types because the diet and rearing methods are comparable in each grouping.

In these trials, at 16 weeks of age, male turkeys had attained an average of 50.2 percent of their 26-week weight while females averaged 60.0 percent of their final weights. Beltsville turkeys were slightly above (males 51.4 percent, females 63.6 percent), while Broad Breasted Bronze were slightly below these figures (males 48.7 percent, females 57.2 percent). Standard Bronze turkeys approximated the average for the three varieties considered.

In the growth of turkeys there is a period in which they attain their greatest rate of gain, and the age at which this occurs differs with turkeys of different type and sex. The period in which Beltsville and Standard Bronze females made their greatest gains in these trials was, in all instances, prior to the 17th week and was about equally divided between the 9- to 12- and the 13- to 16-week periods. Beltsville hens tended to produce their greatest gains slightly earlier than the Standard Bronze, while Broad Breasted Bronze females produced their greatest gains about 4 weeks later than the Beltsville females. In all of these trials, the Beltsville males made their most rapid gains prior to 24 weeks of age, while 40 percent of the Standard Bronze and 75 percent of the Broad Breasted Bronze males had their most rapid rate of growth between the 24th and 26th week. These observations indicate a difference of nearly 4 weeks in the age of arrival at the peak of growth acceleration between male and female turkeys within a given variety, and also suggest a similar difference between these sexes in the

age at which they arrive at a corresponding stage of marketable maturity.

As turkeys approach maturity their rate of gain tends to diminish. In this connection, certain evidences are observed as to differences in time of maturity of turkeys of different type and sex when comparisons are made between the rate of gain during the 24- to 26-week period and the rate of that period in which the particular variety and sex made its most rapid gains. It is of interest to note that these comparisons are consistent with the other observations as to differences in time of maturity between types and sexes. During the 24- to 26-week period, the average rate of gain with males of the Beltsville, Standard Bronze, and Broad Breasted Bronze varieties was 80, 91, and 98 percent and with females 45, 64, and 67 percent, respectively, of the rate of gain in that period in which these varieties and sexes made their greatest rate of gain.

These and other observations suggest that there is a difference of as much as 3 or 4 weeks between Beltsville and Broad Breasted Bronze turkeys of either sex, in arriving at a given point in the final stages of maturity.

Feed Consumed Per Pound of Gain

In computing the efficiency of a diet it is advisable to consider the proportion of mash to grain, as well as the total quantity of these ingredients, required to produce a pound of gain (Table 3). The

TABLE 3—*Pounds of feed consumed per pound of gain (average to 24 weeks of age)*

Feed	Pen												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Mash	3.41	2.54	3.14	2.66	3 57	2.20	3.31	2 50	3.18	2.96	1.84	2.75	2.16
Corn	.81	.88	.68	.66	1.03	1.02	.92	.82	1.10	.92	1.68	1.36	1.11
Oats	—	.76	.77	.49	—	1.08	.95	.77	.52	.53	1.01	.90	.60
	4.22	4.18	4.59	3.81	4.60	4.30	5.18	4.09	4.80	4.41	4.53	5.01	3.78

tendency for whole oats to result in a material reduction in the amount of mash consumed may be noted in comparing the results with Standard Bronze turkeys in pens 1 and 2 and also pens 5 and 6. Pens 2 and 6 receiving both oats and corn consumed an average of 32 percent less mash than pens 1 and 5 which had only corn as grain. The

proportion of feed by periods and the average pounds of mash and grain consumed per pound of gain are given in tables 2 and 3, respectively. The pounds of feed required to produce a pound of gain is distributed by periods in Table 3A.

TABLE 3A—*Pounds of feed consumed per pound of gain (distributed by periods)*

Pen	1–4 Weeks		5–8 Weeks		9–12 Weeks		13–16 Weeks		17–20 Weeks		21–24 Weeks		25–26 Weeks	
	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain	Mash	Grain
1	2.14	0.0	2.43	0.0	3.52	0.02	4.26	0.08	4.23	0.92	2.63	3.35	2.71	5.88
2	1.99	0.0	2.37	0.0	3.42	0.01	2.21	1.61	2.56	2.73	2.47	3.94	1.38	4.19
3	2.42	0.0	3.16	0.0	3.45	0.30	2.96	1.25	3.42	2.73	3.31	3.10	2.05	4.56
4	2 12	0.0	2.70	0.0	2.57	0.40	2.58	0.99	3.03	1.87	2.89	2.42	2.55	4.12
5	2.04	0.0	2.75	0.0	3.59	0.01	4.96	0.09	3.61	1.27	3.22	3.88	1.82	7.19
6	2.32	0.0	2.90	0.0	1.84	1.28	2.18	2.43	2.60	2.52	1.99	4.21	1.00	6.10
7	2.33	0.0	3.01	0.0	3.38	0.51	3.53	2.02	3.93	2.99	3.18	2.78	2.50	7.14
8	2.63	0.0	2.67	0.0	2.17	0.91	2.63	1.52	2.78	2.35	2.57	3.14	2.02	4.06
9	2.53	0.0	3.13	0.0	4.02	0.10	4.06	1.01	2.69	2.56	2.53	4.29	3.54	5.49
10	2.82	0.0	2.70	0.0	3.70	0.00	3.21	1.19	2 78	2.14	2.67	3.36	0.60	3.92
11	2.25	0.0	2.52	0.0	1.53	2 08	1.81	2.70	2.07	3.33	1.60	4.49	1.17	5.96
12	2.45	0.0	3.03	0.0	2.30	1.40	2.89	2.82	3.42	2.98	2.50	3.67	2.90	10.36
13	2.17	0.0	2.63	0.0	1.96	1.09	2.24	1.78	2.13	2.09	1.98	2.85	1.27	3.95

Average Cost of Producing a Pound of Gain

In determining the merits of any ration, the cost of producing a unit of gain is one of the factors to be considered. This information is given for each pen in Table 4. Consideration should also be given to the normal development of the birds, the growth rate, the character of the finished product, and any other advantage or disadvantage of a particular ration before final conclusions are made. A ration that produces the cheapest gains in one year may not be so economical in another year because of changing prices. Thus, in 1944 the price paid for corn was 70 percent of the cost of mash while wheat was obtainable at 55 percent of the mash cost. Under such conditions, rations using relatively large amounts of wheat may produce cheaper gains than if the situation is reversed. In the 1945 trials, the inclusion of oats resulted in a substantial reduction in cost of gains even though the price paid for oats was slightly higher than that of corn on a pound basis.

TABLE 4—*Feed cost per pound of gain (average to 24 weeks of age)*

Feed	Pen												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Mash......	$0.140	$0.104	$0.129	$0.109	$0.154	$0.095	$0.142	$0.108	$0.128	$0.119	$0.079	$0.118	$0.091
Corn......	0.020	0.022	0.017	0.017	0.026	0.026	0.023	0.020	0.028	0.023	0.042	0.034	0.025
Oats.......	—	0.020	0.020	0.013	—	0.028	0.025	0.020	0.014	0.014	0.026	0.023	0.017
Mash and grain total	$0.160	$0.146	$0.166	$0.139	$0.181	$0.149	$0.190	$0.148	$0.170	$0.156	$0.147	$0.175	$0.133

Feed Prices

The average prices paid per 100 pounds for the different mashes and grains in 1945 were: Mash 7, $4.10; mash 13, $4.35; mash X, $4.00; whole corn, $2.50 and oats, $2.60. Since 1940, the average price paid for corn and oats averaged 62.8 percent of the price paid for mash 7. The price paid for corn varied from 57 to 69 percent and oats 58 to 68 percent of the mash 7 price in different years. In the 1945 trials the average price paid for corn was 61 percent and for oats 63 percent, of the price paid for the mash. This was regarded as a reasonable relationship under our conditions.

Growth Rates

The rate of growth of the three varieties of turkeys used and the results with different feed combinations may be noted in Table 5. This

TABLE 5—*Growth of turkeys (average weight in pounds)*

Pen	4 Weeks		8 Weeks		12 Weeks		16 Weeks		20 Weeks		24 Weeks		26 Weeks	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1........	0.94	0.87	2.6	2.3	5.6	4.6	9.0	7.1	12.8	9.3	16.1	11.2	17.8	12.0
2........	0.98	0.90	2.7	2.2	5.9	4.6	10.2	7.5	13.9	9.3	17.1	10.9	19.5	12.2
3........	0.91	0.83	2.5	2.0	5.2	3.9	8.6	6.2	11.6	7.5	14 6	8.7	16.2	9.4
4........	1.19	1.02	3.5	2.9	7.6	5.9	12.7	9.3	16.9	12.0	22.0	14.3	24.4	15.8
5........	0.96	0.89	2.7	2.4	5.7	4.9	8.9	7.4	12.8	9.6	16.4	11.7	17.7	12.5
6........	0.90	0.86	2.6	2.3	6.1	5.0	10.1	7.4	13.8	9.5	17.5	11.6	19.5	12.4
7........	0.87	0.76	2.3	1.9	5.1	3.9	8.1	5.7	11.2	7.1	13.9	8.6	15 3	8.9
8........	1.10	1.01	3.3	2.8	7.5	6.3	12.1	9.7	16.3	12.3	21.1	15.0	24.0	16.1
9........	0.85	0.77	2.5	2.1	5.0	4.0	8.0	5.9	11.8	7.8	14.8	9.2	16.4	9.7
10........	0.93	0.81	3.1	2.6	6.5	5.3	11.0	8.4	16.1	11.7	21.0	14.3	23.8	15.3
11........	0.93	0.79	2.8	2.2	6.1	4.5	10.0	7.2	13.9	9.6	18.3	11.7	20.4	12.5
12........	0.86	0.79	2.4	1.9	5.0	3.7	7.7	5.4	11.1	6.8	14.7	8.3	15.7	8.5
13........	1.18	1.06	3.4	2.9	7.5	5.7	12.0	8.5	17.1	11.3	22.8	14.2	25.9	15.5

table gives the average weight of both male and female turkeys at the end of each 4-week period to 24 weeks of age, and the results to 26 weeks of age is also included. The final weight summary is given in Table 6.

TABLE 6—*Final weights of turkeys in pounds at 24 weeks of age*

	Pen												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Birds started....	25	25	25	25	25	25	25	25	25	25	25	25	25
Surviving birds..	24	25	25	24	24	24	25	24	24	22	25	24	24
Total weight (lb.)	308.0	359.1	300.3	459.2	341.4	316.4	272.9	420.2	288.2	394.9	404.8	295.7	469.6
Number of males	8	14	14	15	13	8	11	10	12	12	17	15	15
(*pounds*)													
Heaviest male...	18.2	19.1	17.2	29.3	18.9	19.8	17.4	24.5	16.2	23.6	19.6	16.6	25.9
Lightest male...	12.4	14.5	13.1	17.9	14.2	16.2	11.7	14.0	12.9	15.8	12.9	12.5	19.8
Average weight..	16.1	17.1	14.6	22.0	16.4	17.5	13.9	21.1	14.8	21.0	18.3	14.7	22.8
No. of females...	16	11	11	9	11	16	14	14	12	10	8	9	9
(*pounds*)													
Heaviest female.	12.3	12.3	9.8	15.5	12.6	13.4	9.4	17.8	9.8	15 4	12.8	8.8	16.5
Lightest female..	9.5	9.8	7.7	13.2	10.4	10.6	8.0	13.1	8.7	12.2	10.2	7.8	13.2
Average weight..	11.2	10.9	8.7	14.3	11.7	11.6	8.6	15.0	9.2	14.3	11.7	8.3	14.2

SUMMARY

Under a free-choice system of feeding used in these continuing trials turkeys have tended to develop a characteristic feeding pattern for each mash, each grain and each mash and grain combination, which they have followed with remarkable consistency from year to year.

The type of turkey used seems to have a greater influence on the total amount of feed that will be consumed per pound of gain than any other single factor.

Small-type turkeys have tended to consume slightly more and large-type turkeys slightly less total feed per pound of gain than turkeys of intermediate type; this tendency, also, has been remarkably consistent.

The range of difference between small and medium and also between medium and large-type turkeys, in amount of feed consumed per pound of gain, characteristically has been from 0.2 to 0.4 pound, when results were computed to 24 weeks of age.

When mashes of relatively high-protein content (above 25 percent) were fed, turkeys have tended to consume fewer pounds of mash and a higher percentage of their total feed in the form of grain, and usually have made heavier final weights, generally at lower cost, than when mashes of lower protein content were used.

In repeated trials, when whole oats were included with corn, for the grain part of the diet, turkeys have consumed approximately 30 percent less mash, regardless of the protein content of the mash.

In the 1945 trials, female turkeys tended to arrive at the peak of growth acceleration approximately 4 weeks earlier than males of the same variety. Beltsville Small White turkeys, of either sex, were 3 to 4 weeks earlier than Broad Breasted Bronze in arriving at that period in which a variety attains its greatest rate of growth. Similar differences were observed as to time of arrival at a corresponding stage of market maturity.

A TEST OF HUNTING AS COTTONTAIL CONTROL

By M. D. PIRNIE

CONSERVATION INSTITUTE AND SECTION OF ZOOLOGY

THE COTTONTAIL RABBIT* is widely distributed and quite abundant on many Michigan farms. It is an important game species, and the annual take by hunters has been estimated by Hickie (4) to exceed 2,000,000 animals. Also, these rabbits are sometimes very destructive to ornamental shrubbery, young orchards and forest seedlings, and to garden crops. The game law provides for the issuance of control permits; but one often hears it argued that open-season shooting will give all of the necessary control.

In southern Michigan the open season has extended from October 15 only to the end of December, but in more northern counties of the lower peninsula hunting may continue to the end of January. There is a popular belief that rabbits cannot stand a longer season in the southern zone because of the greater hunting pressure in thickly settled regions. Actually there is little proof on this subject. In 1931, Aldo Leopold (5), writing of the lakes states area, said, "There is no unanimity of opinion, for instance, whether shooting greatly affects rabbit abundance." Even now, this statement holds.

While serving Michigan State College as director of its W. K. Kellogg Bird Sanctuary from 1931 to 1948, the writer had an excellent opportunity for a test of cottontail control by shooting. This College property is located 12 miles from Battle Creek and is in a region of cottontail abundance. Together, the Kellogg farm and bird sanctuary offered nearly 600 acres of assorted rabbit cover—farm fields, swales, woodlots, brush patches, and conifer plantations—where the hunting could be controlled and accurate kill records obtained. Here was a nearly ideal place to study cottontail survival under heavy, regular shooting. Several graduate students helped in many ways, notably D. L. Allen in 1936 and 1937. Many thanks are due C. M. McCrary,

**Sylvilagus floridanus mearnsii* Allen

ARTICLE 31-33

superintendent of the Kellogg Station,* for his cooperation which made possible this long-time test.

Although the rabbit season opened on October 15, the test shooting was postponed until December and generally restricted to that month for the following reasons: a) to avoid disturbing the wild ducks and geese using the Kellogg Bird Sanctuary, b) because rabbits are well-grown and usually fat in December, and c) hunting is more effective with snow on the ground. (Present knowledge indicates another reason in favor of late rabbit hunting: that risk of catching tularemia from handling rabbits is very much less in December than in October.)

For 16 consecutive Decembers, 1932 through 1947, the shooting was kept as uniformly heavy as possible, taking into account the great variation in snowfall and other weather conditions. No rabbit refuges were set aside and no attention was given to saving breeding stock; for this was to be a test of how well the cottontail could "take it," and it was to be a test of heavy and regular shooting as a possible control measure.

Figure 1 shows the number of cottontails bagged each December from 1932 through 1947 when the test ended. The total recorded kill was 1,649 rabbits, an average of 103 for each of the 16 years. The take varied from a low of 60 to a high of 172. Since the shooting took place on less than 500 acres, the average yield was one rabbit from about

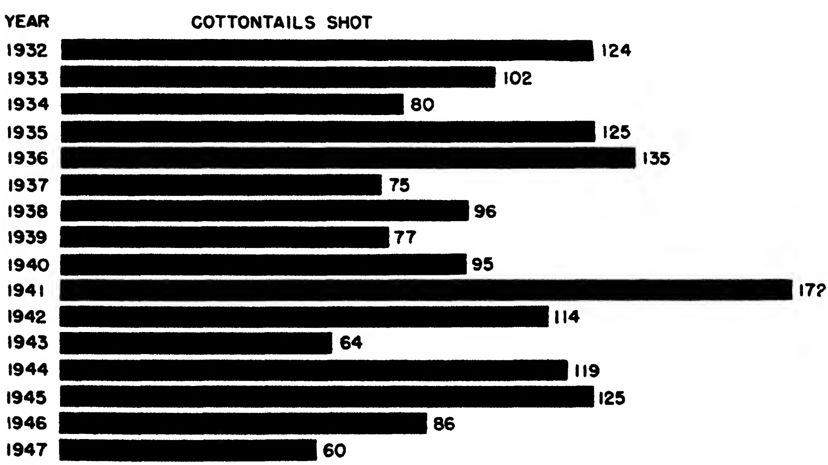

Fig. 1. December kill of cottontails by control shooting.

*In 1948 the W. K. Kellogg Farm, Forest, and Bird Sanctuary—all three projects near Gull Lake in northeast Kalamazoo County—were renamed the "Kellogg Station of Michigan State College."

5 acres. This is very close to the calculated yield listed by Hickie (2)—an average of 110 rabbits annually from each section of land (640 acres) in the southern counties. It seems evident that this test was conducted on well-stocked rabbit range and that the shooting removed at least as many cottontails as would have been taken by ordinary hunting.

The shooters were wildlife students and members of the farm and bird sanctuary staffs, plus a few guests. The hunts were carefully planned both for safety and for uniform coverage of the tract. Occasionally lone hunters used small-bore rifles, but the usual firearm was the shotgun. Rabbit hounds were seldom worked; but many rabbits were routed from the pines and spruces and from bittersweet tangles by the writer's springer spaniel and Chesapeake retriever, and by McCrary's Boston terrier.

The hunting was chiefly by "drives" in which from five to fifteen hunters participated. Since cottontails are not easily driven, most of the hunts were conducted in skirmish line, with the shooters spaced several rods apart. This permitted safe shooting at most rabbits jumped; but this type of hunt is no place for careless shooters or novices.

Fifty-two of these larger group hunts, or drives, yielded 907 cottontails, an average of 17.5 rabbits per hunt of about 5 hours. This figures 2.5 rabbits per hunter, or 2 hours per gun for each rabbit bagged. As many as 52 were taken in one full-day hunt. This form of control would be quite expensive, we fear, if the landowner had to buy ammunition and hire shooters. Actually, there always was a waiting list of willing helpers, but for safety and ease in directing the hunts, we preferred experienced gunners.

Smaller hunts by one to four men took a total of 742 cottontails in 174 forays. These hunters bagged a rabbit, on the average, every 1½ hours per gun, a slight advantage over the average of 2 hours required in the drives. The small hunts had a distinct advantage, for many of them took place in late afternoon, when cottontails are especially active and therefore more easily seen and shot.

Rabbit survival at the close of the shooting period was indicated by their tracks in the snow and by observing them in early morning and at dusk. We found that quite a few cottontails were enjoying the protection of culverts or living in the dens of other animals and under the field poultry houses. Our best evidence that the well-planned,

intensive shooting missed many rabbits was obtained, however, by rabbit population studies made on the test area between 1935 and 1937 by D. L. Allen, a graduate student (1, 2). Allen box-trapped and ear-tagged local cottontails between January and March 1937, and found over 50 animals present, in spite of the kill of 135 removed the previous December. His work indicated we might be shooting not over 60 percent of the rabbits present on the area when shooting began: and this could scarcely be considered effective control!

In spring we often saw five or six cottontails in sight at one time. This was more than were jumped on some of the last shoots. No matter how low the December kill had been, each spring and summer seemed to have a good breeding stock and fair numbers of baby rabbits. Abundant rabbits in summer, however, did not always mean large numbers in December. In the summer of 1947, for example, the animals were very abundant, but shooting that December was the poorest in 16 years! Shooting is by no means the only mortality factor.

During these studies, both Allen and the writer came to the conclusion that many factors other than shooting affected rabbit populations on the test area. Allen found diseases more prevalent in late winter; in one week in March 1936, the writer found three cottontails which were evident victims of disease. Predators of many kinds were present, but we found no direct relation to cottontail numbers. Rabbits showed no increase when skunks almost completely disappeared from the area; and our best harvest of cottontails came in 1941 when red foxes were regularly present.

Regardless of what factors kept rabbits from being more abundant, the fact remains that neither shooting, diseases, nor predators prevented fairly successful recovery each year of the test. Since the surviving rabbits destroyed or damaged dozens of young beech, mountain ash, and hemlock trees which we had set out but not yet protected by wire guards, the test failed to give the sort of control sought in commercial tree nurseries and in young orchards.

If shooting is to be considered a useful means of local control of cottontails in Michigan, it seems that the open season would have to be greatly extended or special permits given to allow shooting, not only when damage is being done, but also from the end of the shooting season well into the spring. Such local attempts at control could have little effect on cottontail populations throughout the state.

Good conservation practice demands raising those crops for which the land is best adapted, whether lettuce or rabbits. Also, it is good

wildlife management to grant wildlife species no more protection than each needs in order to survive in reasonable numbers appropriate to the farm or forest areas which they occupy. Certainly we should not fear to apply control measures against an animal with the "come-back" which the cottontail has repeatedly demonstrated.

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THE RELATION BETWEEN DIFFERENT METHODS OF APPLYING PARATHION AND THE AMOUNTS DEPOSITED ON APPLE LEAVES FOR THE CONTROL OF EUROPEAN RED MITE

By A. E. MITCHELL, HERMAN KING, EILEEN K. CARR, and E. J. BENNE

SECTIONS OF HORTICULTURE, ENTOMOLOGY AND AGRICULTURAL CHEMISTRY

THERE IS CONSIDERABLE interest among fruit growers for a more rapid and efficient means of applying spray chemicals used in fruit growing. The following investigations were undertaken to evaluate, as far as possible, different methods of applying spray chemicals including concentrate sprays, wet-dusts, dry-dusts and conventional hydraulic sprays.

A variety block of approximately 110 mature apple trees located on the Michigan State College Horticultural Farm, East Lansing, was used for this study. The trees were uniform in size within varieties and heavily infested with European red mite (*Paratetranychus pilosus*, Canestrini and Fanzago) (Table 1). Parathion (O, O-diethyl O-p-nitrophenol thiophosphate), a new organic acaricide[1], was used in comparing the various methods of application. This material was

TABLE 1—*Effectiveness of various methods of applying parathion to apple trees for the control of European red mite*

Treatment*	Actual parathion applied per tree, in ounces	Average number of mites per 62.5 sq. in. of leaf area			
		Time of application	Days after application		
			4 days	11 days	21 days
Conventional spray	1.28—1.44	97	5	16	15
Concentrate spray	1.22—1.50	108	1	10	7
Wet-dust	1.20—1.44	91	1	14	8
Dry-dust	1.20—1.44	98	2	37	38
No Treatment	—	65	5	51	52

*Treatments made August 5, 1948, between 7 p.m. and 9 p.m.

[1]An acaricide is a substance or preparation which kills acarids or mites.

ARTICLE 31-34

selected because a quantitative procedure is now available to determine residues of it on plant tissues, and also because when properly used it has proved to be very effective for European red mite control. The treatments were made across the variety rows to insure uniformity of comparisons. Two rows of guard trees were used on each side of the dust treatments, and a single row of guard trees was used between spray treatments to avoid confusion in results because of drift.

The Bean Mist-Duster[2] with a fixed outlet was used to apply the dry-dust, wet-dust and concentrated spray materials. A Bean hydraulic sprayer with a 20-gallon capacity pump, operating at 600 pounds pressure, equipped with an 8-nozzle hand-operated broom, was used to apply the conventional spray.

Before any treatments were made the rate of discharge of material was carefully calibrated for each method of application, and this was coordinated with the rate of speed at which the machine would pass the trees to be treated. The calibration was made so as to insure the same quantity of controlling ingredient per tree per treatment. The conventional hand-sprayed treatment was used as a basis for the quantity to be applied, as it was first determined that the trees in this treatment would require 15 to 18 gallons of spray, depending upon the variety. The range was necessary because the treatments included several varieties, and some require more spray or dust than others for complete coverage because of natural tree size differences. This tree size difference was considered also in applying the treatments with the Bean Mist-Duster, in that it would take longer to pass by a large tree than a small one if the machine were moving at a uniform rate.

The treatments were made on the evening of August 5, 1948, between 7 p. m. and 9 p. m. when air conditions were ideal for any type of spray or dust application. All the trees were sprayed or dusted from opposite sides to insure complete coverage. During the following 48 hours the guard trees were sprayed carefully by hand to avoid any drift, using 1 pound of 25-percent parathion per 100 gallons of spray. This was done to eliminate any possible migration of mites from the guard trees to the treated trees.

Counts of European red mite were made on August 5, 1948, prior to the acaricide treatments and again 4, 11 and 21 days later (Table 1). Twenty-five medium-sized spur leaves, one from each spur, were col-

[2]Manufactured by the John Bean Manufacturing Company, Division of Food Machinery Corporation of Lansing, Michigan. This machine operates as a concentrate sprayer, dry-dust or wet-dust applicator. An air blast of 120 miles an hour, created by a paddle-wheel-type fan, carries the spray or dust material from the machine to the tree.

lected from each tree. The leaf samples were gathered from spurs selected at random, 5 to 7 feet above the ground level, from the inside and the perifery, entirely around the tree. Only one leaf was selected from each spur. A total of 62.5 square inches of leaf area per tree (this includes two counts per leaf) was observed for European red mite infestation (Table 1). The counts were made on a magnified field of 1.25 square inches, observing both the upper and lower surfaces of the leaves. The field for the mite count included the middle portion of the leaf blade, the midrib dividing the field into equal portions.

Samples of leaves to determine the amount of residual parathion were taken on August 7, 19 and 26, 1948, in the same manner as those used for the mite counts . The leaves from all the trees in one treatment were composited, and the leaves actually used in the analysis were selected at random from this sample. Residual parathion was removed from the leaves by extraction with benzene and evaluated photometrically by the method of Averell and Norris[3]. The results are given in Table 2.

TABLE 2—*A comparison of the quantities of residual parathion deposited on the leaves of apple trees by various methods of application and its resistance to weathering*

Treatment*	Actual parathion applied per tree, in ounces	Residual parathion in p.p.m.		
		Days after treatment		
		2 days	14 days	21 days
Conventional spray	1.28—1.44	79.1	15.2	3.2
Concentrate spray	1.22—1.50	107.6	31.2	10.9
Wet-dust	1.20—1.44	38.6	7.1	0.8
Dry-dust	1.20—1.44	8.8	0.4	3.8
No treatment	—	0	—	—

*Treatments made August 5, 1948, between 7 p.m. and 9 p.m.

A comparison of the mite counts shows little to no differences in the effectiveness of the wet-dust, concentrate spray, and conventional spray even though the residual quantity of parathion for the concentrate spray was approximately three times greater than that for the wet-dust and one-third greater than that for the conventional hydraulically applied spray. The dry-dust treatment resulted in the smallest quantity of residual parathion and was the least effective against the mites. This was probably due to the trees being dry at the time the treatments were made.

[3]Analytical Chemistry, 20: 753, 1948.

The amounts of residual parathion (Table 2) may induce one to believe that the quantity of actual parathion, if applied in concentrate form, could be reduced to at least two-thirds of that used in this test, and still give good prolonged commercial control of European red mite. By the same reasoning, the quantity of actual parathion used in the conventional spray application could be reduced at least 50 percent.

It is of economic interest that even though approximately the same quantity of actual parathion was applied per tree per treatment (Table 1), the amount of residual parathion on the leaves was much greater for the concentrate application than for the other treatments. This was due no doubt to little or no run-off when the spray was applied in concentrate form. Also, more actual parathion was retained on the leaf surface by the wet-dust treatment than by the dry-dust treatment. It is known that less dust fungicide and insecticide are retained on dry plant surfaces than if applied when the plant is wet with dew or rain, and the trees used in this experiment were dry when the parathion applications were made. It is of interest that the European red mite infestation was not entirely eliminated by any of the treatments. The probable explanation of the reduced population of mites on the check trees 4 days after the parathion treatments is that sufficient parathion volatilized into the atmosphere surrounding the check trees to kill any mites that were present. However, newly hatching eggs quickly rebuilt the population to almost its original figure. This was to be expected as there was no residual parathion on the leaves of these trees to kill the larvae as they continued to hatch.

The results of this investigation are of interest in that they suggest the possibility of reducing the quantity of spray chemicals that may be used effectively when these chemicals are applied as a concentrate spray in place of the conventional spray, wet-dust, and dry-dust.

A SELF-LOADING AND SELF-UNLOADING WAGON FOR LONG HAY

By *S. T. DEXTER*
SECTION OF FARM CROPS

WHEN LABOR REQUIREMENTS in handling dry or tough long hay with a hay loader and a fork or slings, are considered and classified the following facts emerge:

1. *Cutting*—Little muscular effort, no dust, no discomfort.
2. *Raking*—Little muscular effort, little dust, no discomfort.
3. *Driving tractor on loader*—No effort, or discomfort; little dust.
4. *Working in front of the hay loader*—Loading the hay on the wagon is very heavy muscular work, even for a young man; two men required for large racks; frequent stoppages and delays under even the best circumstances, because of handling the hay. Considerable dust, much discomfort. Not a popular job for hired labor.
5. *Driving to the barn*—No effort, dust or discomfort.
6. *Handling the grapple forks, etc., in unloading*—Considerable muscular effort, dust and discomfort.
7. *Mowing the hay away in the barn*—Great muscular effort; very hot work; dusty; much discomfort. A very unpopular job.

From the analysis above, it is evident that great improvement is possible in the operations of loading, unloading and mowing-away.

It is no wonder that these jobs are unpopular, and that field choppers and balers have been developed to speed up or eliminate or, particularly, to take the "sweat and muscle" out of these jobs.

Yet, for the farmer handling an ordinary amount of hay—say, perhaps 40 or 50 tons—these expensive machines seem hardly practicable from the viewpoint of expense, if sufficient labor can be hired to help do the work as described above—the hard way. The operations of cut-

ARTICLE 31-35

ting and raking are common to all systems of hay making. Traveling the length of a windrow with a field chopper is not necessarily more rapid than traversing it with a hay loader. The difficulty lies in the extreme muscular effort involved in attempting to distribute the hay that a constantly moving loader will deliver onto the rack.

In order to avoid the necessity of great muscular effort in loading the hay, it is evident that the hay must not be carried or moved any great distance, if at all, by hand. To accomplish this, the hay, whether dry, tough or green, should fall from the loader approximately into its final position. If no one is on the load, as may be the case with tough hay for a mow drier, or green hay as in silage, no handling whatsoever is involved, as will be described below. In handling dry hay, however, the operator may wish to take very bulky loads, and to use a man on the rack to tramp the hay and arrange it to some extent.

To accomplish this easy loading, a false floor, or platform should be provided, which will slide toward the front of the wagon, at intervals, until the entire rack is filled. Briefly, it was decided to attach a piece of canvas to a short sliding platform, to accomplish the following several ends: 1) The false floor should not stick out behind the wagon, and interfere with the loader; yet it should always be present for the hay to fall upon since, by this means, very large and long racks may be used, and the load may be put on in several segments. 2) On unloading, the false floor should not project past the end of the wagon, but should simply disappear. Several additional methods of accomplishing this are evident, such as, for example, the endless slatted floor of the manure spreader.

In the fall of 1947, a crude experimental model was constructed at Michigan State College (Figure 1). Since it performed according to expectations, the suggestion was passed on to Mr. F. W. Steere, of Pontiac, who had need for just such a device for loading and unloading green or tough hay at his hay drier, and who proceeded to construct a wagon for his own use. His wagon was used successfully all through the 1948 season.

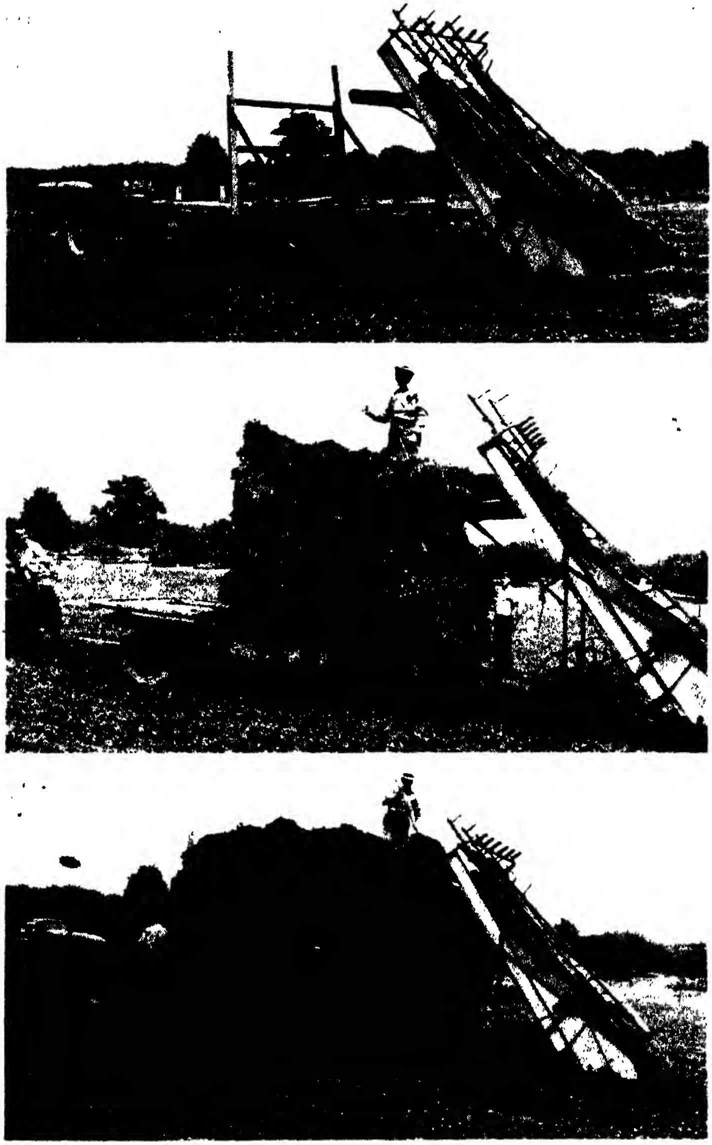

Fig. 1. The self-loading wagon empty, almost half loaded and completely loaded with ladino clover hay.

Figure 2 shows a general view of the wagon from the rear, with the rear stakes removed. The flat wagon bed was extended on the sides to give as large a platform as practicable—10 x 14 feet. To the short sliding platform, two steel cables were attached, running along the top of the platform, over a roller at the back, then under the rack and back, around a front roller and to the platform. The front roller is equipped to pull the cables, and thus move the platform in either direction. This will be described below. To the short platform was attached a piece of canvas, lying on top of the wire cables, and covering the rest of the flat rack.

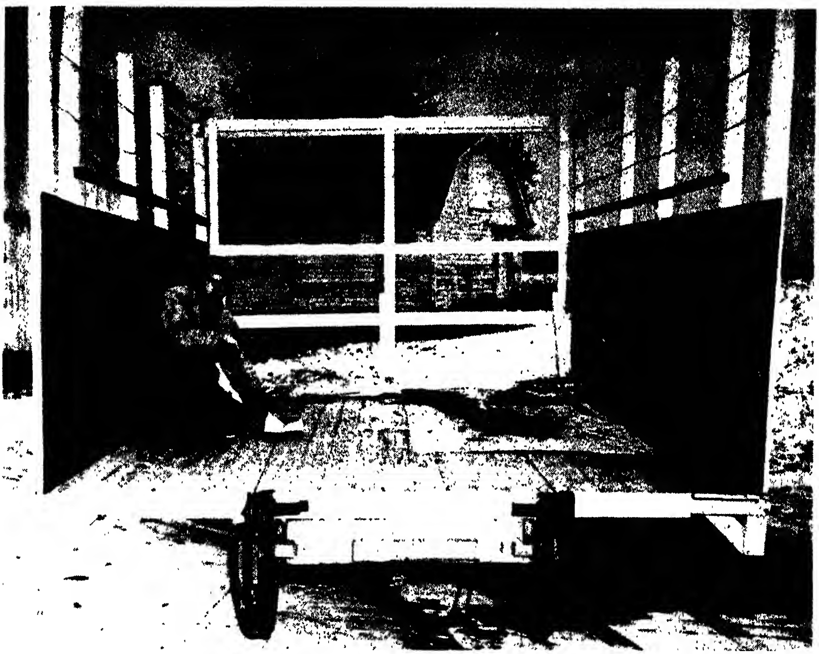

Fig. 2. A general view of Mr. Steere's wagon from the rear, with the rear stakes removed. Note the two cables and the canvas attached to the short sliding platform.

Figures 3 and 4 show a close-up of the arrangement of the cables on the front roller. The cables are wound around this roller in such a manner that as cable is taken up on one side of the anchor, it is played out on the opposite side. Evidently, a sufficient length of cable must be wrapped on the roller so that the platform can be moved approximately

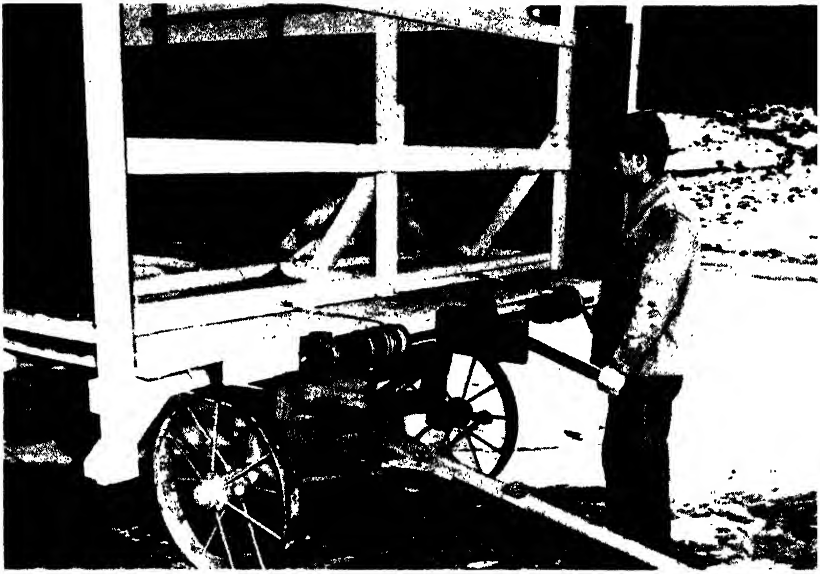

Fig. 3. A front view of the wagon. By lifting up on the lever the operator has slid the platform a few inches toward the back of the wagon. By reversing the ratchet and pushing down on the lever, he can slide it forward.

the length of the rack. Thus, when the platform is at the front of the rack, about 15 feet of cable is wrapped on one side of the anchor, while if the platform is moved to the back of the rack, this cable will unwind on one side of the anchor and appear on the opposite side. An anchor is necessary to avoid slipping of the cable on the drive shaft. The shaft is turned with a lever and ratchet attachment, and, in this case, was operated by hand. One man easily slid the load in either direction.

USE OF THE WAGON AT THE STEERE DRIER

On the Steere farm, all hay is dried artificially. The wagon, loaded with hay, was backed into position at the unloading platform, where the uncured hay was fed by one man into the drier. In the field, no one rode in the wagon. Loads of approximately ¾ ton of dry hay were hauled. Loading was accomplished by pulling the loader off-center on the windrows, first on one side and then on the other. When the hay was piled as high as the loader would deliver it, the platform was pulled forward, and the process repeated until the load was complete.

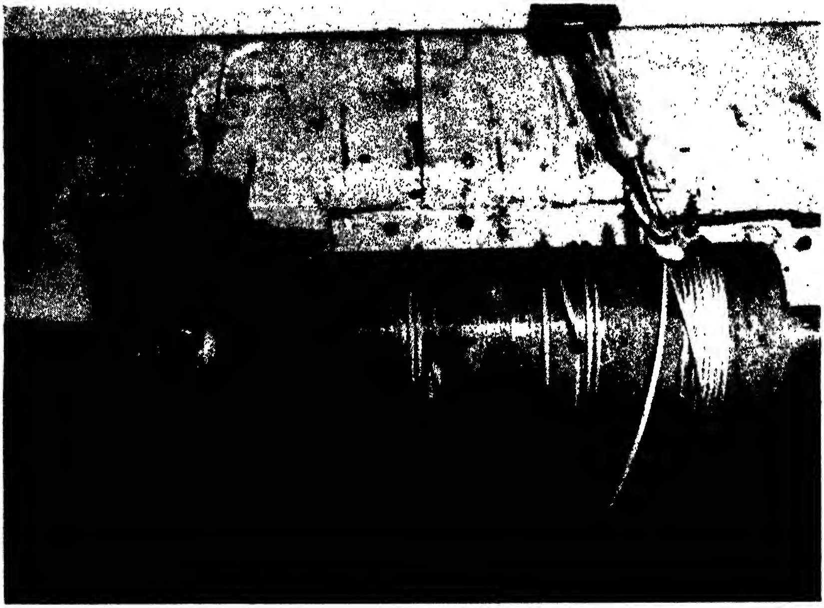

Fig. 4. A close-up of the roll, showing the holes through which the cable is threaded to anchor it. The cable is now wound up on the right of these holes. When the sliding platform is at the rear of the wagon, the cable will be wound up on the left side, having been unwound from its present position.

At the unloading platform, the hay could be taken off conveniently, because the last hay put on was the first hay taken off. Furthermore, the load was in more or less definite segments, and there was much less tangling than when a load has been loaded from the bottom up, rather than from the front, to the back. Periodically the load was pulled back so that it was convenient to the workman who was feeding the drier. This was done by the man in charge of the dehydrator.

The use of this wagon saved the hard labor of at least two men—one in the field, loading, and one at the drier, pitching hay to the feed platform. Both of these jobs are very hard work, when handling damp hay.

USE OF THE WAGON IN ORDINARY HAY MAKING

How to use this wagon will be obvious to the experienced haymaker. One or two points might be mentioned, however.

1) If the long hay is to be unloaded with slings and grapple forks

and the unloading device will not be used, the cables need be arranged only to pull the sliding platform and canvas forward on the wagon. Thus, although the wagon may save much heavy work and time in loading, it may not be helpful in solving the unloading and mowing-away problem in such cases.

2) Yet, if the unloading feature were used in connection with a stationary hay chopper (silo-filler), long-chopped hay might be blown into the barn, and the work of mowing-away completely eliminated. Particularly this should be helpful in the cases where mow-driers are used. It has been a common observation that the field chopper will deliver chopped hay into the wagon faster than the blower will deliver it into the barn. This is a common bottleneck. Furthermore, unloading field-chopped hay is a dusty, dirty job. From past experience, it seems probable that a self-unloading wagon, as described above, might deliver long hay to a stationary chopper and thus to the barn, at least as rapidly as would a blower, and thus save one blowing operation, with its consequent removal and shattering or powdering of leaves. The chopper would deliver the hay to the mow in this case rather than into a wagon.

RAPIDITY IN THE FIELD

In ordinary practice, travel of the hay loader in the field is not only slow, but is greatly interrupted. Yet the load of hay shown in Fig. 1 was put on without stopping the tractor except while the load was being moved forward, and the tractor driver was constantly urged to drive faster than usual, even though the man loading lacked much of the physical stamina common in hay-makers. The windrows, while not large, were the full width of the rake (two 6-foot swaths) and the hay was very tough and heavy. With windrows 12 feet apart, a windrow 3,620 feet long would make one acre. This is approximately 7/10 of a mile. It is evident that with continuous travel of the loader, an acre of hay can be picked up rather quickly.

SIZE OF LOADS

When loading hay in the ordinary way, much of the hay must be dragged, pitched or carried to the far end of the rack. With a rack more than 12 or 14 feet long, this causes great delay when but one man is riding the load. With this device, there seems to be no reason why much longer racks should not be used, since the loading is performed near the loader no matter how long the rack may be.

In a good many instances, as at Mr. Steere's drier, or in making grass silage, there may be little object in trying to haul a load of great volume, since the load becomes very heavy and packed, the wagon wheels tend to cut ruts in the soil, and unloading may become more difficult. Furthermore, our common farm wagons are not constructed to carry these excessive loads. In such a case, this wagon might perhaps be thought of as a modified buck rake, of unusually large capacity.

OPERATION OF MECHANISM THAT SLIDES THE LOAD

In the case of Mr. Steere's wagon, there seemed little to be gained by operating the cable mechanism other than by man-power. In many cases, however, it seems that mechanical operation, as by power take-off might be highly advantageous.

Various substitutions for operation of the cable such as 1) a chain drive, with cog wheels, for the cable drive or 2) a cable (or cog) drive roller at both front and back of the rack, might be made without violating the principles of the wagon described. In Mr. Steere's case, the cable mechanism and the manual operation were considered highly economical and effective, and yet not at all arduous. There seemed, furthermore, nothing to get out of order in this arrangement.

SUMMARY

A wagon has been described that is simple and inexpensive to build and operate; it is partially or entirely self-loading and self-unloading with long hay.

It is suggested that with this device, hay making may be speeded up and the heavy manual labor materially decreased with but little capital investment.

FACTORS AFFECTING THE DESIGN OF A MILK HOUSE

By JAMES S. BOYD

SECTION OF AGRICULTURAL ENGINEERING

MILK PRODUCTION is one of Michigan's largest industries, accounting for about a fourth of the total annual farm income (6). Sixty percent of this production is handled in the farm milk house. Much of the milk is produced on general farms, and it has been found that chore time accounts for half of the yearly work on these farms. Bookhout (2), in a survey made of 10 Michigan farms, indicates that 18 percent of the chore time with dairy cattle is spent cleaning utensils and caring for milk. Through observation, it has been found that these chores were accomplished more effectively in a properly designed milk house.

Two general classes of milk are sold from the farm–market milk and manufacturing milk for the condensary and cheese plant. These two types of milk markets require different sanitation standards; the fluid milk market is very strict in its requirements, and farmers are required to provide a milk house in which to handle milk. The condensary market is less strict, and many farmers have found a milk house a place where they can do the milking operations with the least possible work. Fluid milk is consumed in essentially the same form as it is produced and cannot be cleaned like other farm products. Pasteurization renders good milk safe, but will not make poor quality milk good. Efforts to improve milk supplies have been gradual throughout the United States, but they have noticeably accelerated as the use of market milk has increased in comparison with that of manufacturing milk.

It is generally accepted that a suitable milk house is essential to a quality milk production program. The attitude of health departments regarding milk houses has changed, and not by accident. For example, Parker (4) in 1917, indicated that the best location for a milk house was from 150 feet to 200 feet from the stable. Since that time, changes have been made in procedure and equipment which make possible a

ARTICLE 31-36

much more convenient location. For instance, the installation of pressure water systems is simplified by attaching the milk house to the stable. The cleaning of milking machines with vacuum lines from the milking machines, the use of electric coolers, and the new methods of controlling flies have made it possible to increase the usefulness of a milk house by attaching it to the barn.

McMillan (5) found that milk did not absorb odors from the air, which had been a factor in the location of the milk house a distance from the barn. In his study, milk which had been exposed to stable odors for one and one-half hours did not absorb them unless the foreign matter causing the odors was allowed to enter the milk. Because of this and other similar studies, it was generally agreed that the milk house could be located close to the barn without contaminating the milk with odors.

REASONS FOR A MILK HOUSE STUDY

In 1946, health authorities renewed a concentrated program to improve the quality of market milk. It was generally accepted that a milk house was important to such a program and a building plan which could be used throughout the state would help this program. It was estimated that 10,000 new milk houses would be constructed in Michigan in the following five years. Health authorities and dairy inspectors, who were interested in the program, desired a plan which would fulfill the milk ordinance requirements. The farmers, who were to build these milk houses, wished to be sure that they would not have to rebuild in a short time because of their milk houses becoming obsolete. The average cost of the milk houses would be about $300, depending on the amount of native materials and the farmer's own labor used.

Ten thousand milk houses, costing approximately $300 per unit to build, would represent an investment of $3 million. If this investment were to be made by industry, very careful planning would be employed to be sure that the best possible building would be constructed. It is equally important that a farmer give careful consideration to the construction of each unit he builds.

REGULATIONS GOVERNING THE PRODUCTION OF MILK

The milk ordinances in the state are the governing rules in milk house construction and will regulate the type of milk house built in

TABLE 1—*Milk ordinance requirements for major Michigan markets, November 1947*

Area	Minimum size	Electric cooling	Milk strained in barn	Utensils washed in barn	Hot water	Location	Cooling and refrigeration	Utility rack
Lansing[21] 1946	none	no	no	no	no	free from contaminating areas	60° within one hour	
Mich. Milk[24] Ord. 1945	none	no	no	no	no	same as above	60° within one hour	12" above floor
Grand Rapids[27] 1942	none	no	no	no	yes	same as above	50° immediately	
Bay City[18] 1940	none	no	no	no	yes		60° within one hour	
Pontiac[26] 1945	20 Gal. 10′ x 12′ 20-50 Gal. 12′ x 12′ 50-100 Gal. 12′ x 14′ 100 Gal. 12′ x 16′	no	no	no	yes	50′ from chickens, hogs or privy	55° immediately	12" above floor
Detroit[19] 1947	10′ x 12′ recommended	no	no	no	yes	same as above	60° within one hour	12" above floor
Chicago[23] 1937	none	no	no	no	yes	free from contaminating areas	65° within one hour	
(Kalamazoo)[29] Fed. Security Agency 1939	none	no	no	no	yes	same as above	50° immediately	
Flint[22]	0-15 Gal. 10′ x 12′ 15-25 Gal. 12′ x 14′ 26-50 Gal. 14′ x 16′	no	no	no	yes	same as above	60° within one hour	
Ann Arbor[17] 1947	none	no	no	no	no	same as above	60° within one hour	12" above floor
Saginaw[28] 1942	none	no	no	no	no	same as above	60° promptly	well ventilated
Battle Creek	none	no	no	no	yes	free from contaminating areas	60° within one hour	metal 12" above floor
Jackson[20]	none	no	no	no	no	not specified	60° immediately	required

the different areas of the state. Twelve large cities in Michigan have dairy plants buying milk and have ordinances controlling the production of this milk. These ordinances have been reviewed and the sections pertaining to milk house construction summarized as shown in Table 1.

From this summary it was found that there was general agreement on items of equipment, but there were differences of opinion as to the size of the milk house.

EQUIPMENT RECOMMENDED FOR A MILK HOUSE

The interviews and field investigations made revealed three main operations that fieldmen and inspectors watched for, and which occur at each milking and have proved essential to the production of high quality milk. These operations are: 1) cooling and storing milk, 2) cleaning and sterilizing equipment, and 3) storing equipment between milkings.

To accomplish these operations most effectively, four items of equipment must be included in the milk house; namely, a milk cooler, a water heater, a double wash vat, and a can rack.

These items of equipment are important to the marketing of clean milk but even when all these are provided in a milk house, the operator cannot be assured of the highest quality milk. This equipment will make the chore easier and help to encourage the production of clean milk, but the farmer still has to do his part. His habits and practices will have a big effect on the quality of milk marketed.

FLOOR AREA REQUIREMENTS

The most variable requirement for milk house construction is the floor area required. Jennings (3) found that the floor area per can necessary to provide adequate space varied inversely as the number of cans produced, and varied somewhat according to the location of the milk house. With milk houses attached to the barn, he recommends a larger floor area than when the milk house is separate from the barn.

The calculated floor area for the milk house equipment is shown on Fig. 1. The space required for the water heater and the wash vats is constant for the range of production considered. The space required for the can rack will vary directly with the number of cans produced and space should be provided for the maximum daily production

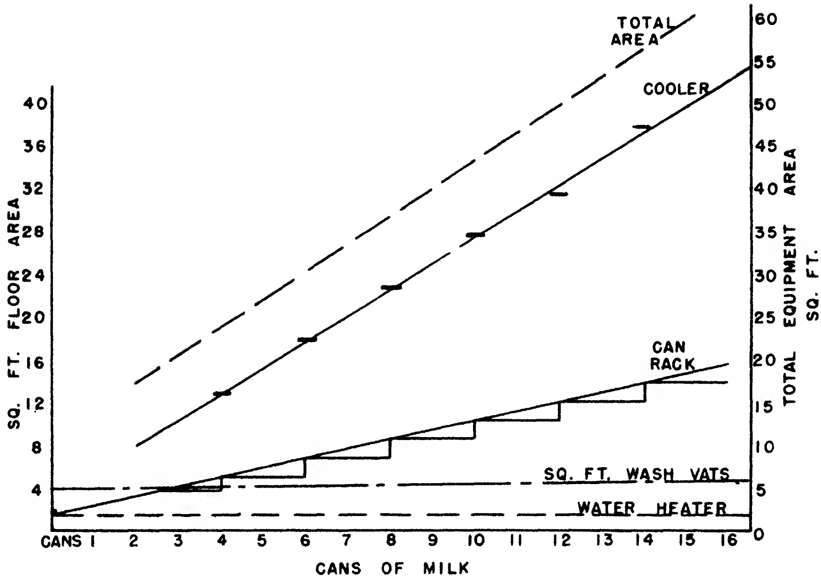

Fig. 1. Floor area requirements for necessary equipment in a milk house.

anticipated. The can rack provides the necessary facilities for keeping the milk cans clean after they return from the dairy plant. This rack should be constructed so that the other utensils used in the milking and cleaning operations may be kept clean.

The space necessary for the milk cooler will also vary directly according to the number of cans of milk produced. This area was calculated on the assumption that only one unit would be used to cool the daily supply of milk. The curve does not start at the origin of the chart because the space necessary for the compressor and motor would be constant for any type of cooler. When two units are to be used to cool the milk, the cooler space will be larger by the amount of space needed for the refrigeration unit.

Figure 2 indicates the floor area required to provide space for equipment and for operation of the equipment. Curve 1 shows the work area necessary to operate the equipment previously described. Curve 2 shows the total calculated floor area, and the difference between curves 1 and 2 represents the floor area required by the equipment. The area required by the milk ordinances is a straight line, curve 3, and the size varies as the number of cans produced. The farmers, in

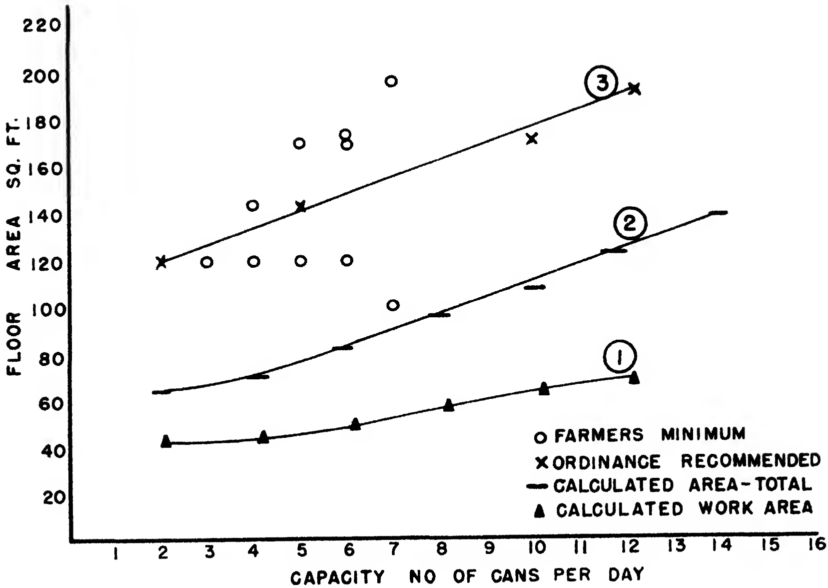

Fig. 2. Total floor area required by milk ordinances, suggested by farmers and calculated from space requirements of equipment.

general, indicated that their present milk house was adequate. Jennings (3) found that one out of four milk houses was too small, while only one of eighty milk houses was too large. A farmer should anticipate his maximum production and build his milk house accordingly, but the milk house should not be so large that there will be space for the accumulation of trash.

LOCATION OF THE MILK HOUSE

Bookhout's studies show that the amount of work done in the milk house varies considerably. The time spent in the milk house, daily, varied from 5.2 to 50.47 minutes. The farm operators studied were milking herds of various sizes, but there was only slight correlation between the number of cows milked and the time spent in the milk house. This indicated that there must be some other reason for not using the milk house for a larger proportion of the milking operations.

A curve was plotted to show the relation between the distance from the stable to the milk house and the minutes spent in the milk house,

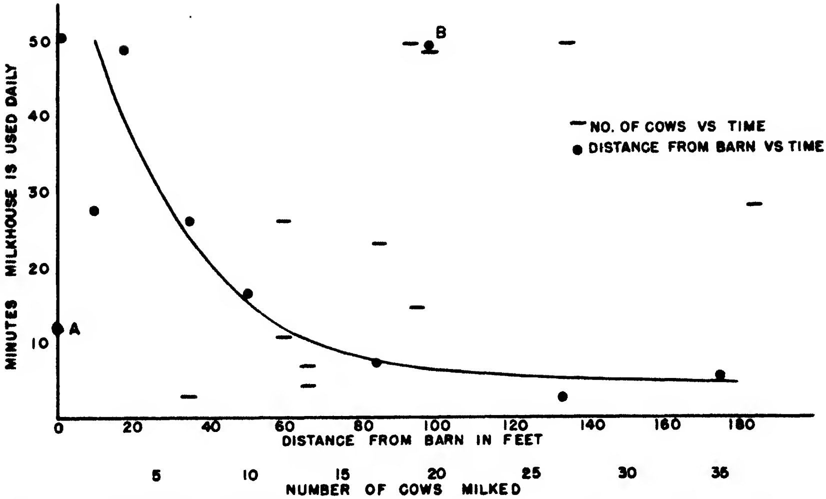

Fig. 3. The effect of location and number of cows on time spent in a milk house.

Fig. 3. This shows that the closer the milk house is to the barn, the more times it was used during the day. Individual farms were studied to determine the operation performed in the milk house, and it was found that the farmer whose milk house was located conveniently to the stable performed more operations in his milk house. The farmer who built his milk house some distance from the barn found it more convenient to perform some operations in other buildings on the farm, which resulted in additional time and travel in doing the chores.

The wide variation in the milking procedures used also affected the time spent in the milk house and the time required to milk the cows. The farmer represented by point A (Fig. 3) attached his milk house to the side of the barn, but was not using the available facilities. His utensils were carried to the kitchen to be washed, and the milk house was used merely as a shelter for the cooler. The farmer represented by point B was also unusual. On this farm, the milk was taken to the milk house and the utensils to the house for washing and sterilizing. The farmer then returned to the milk house and cooled the milk with a small portable cooling unit that had to be changed from one can to the other until the milk cooled.

RELATION BETWEEN TEMPERATURE AND LOCATION

In the milk houses studied in this investigation it was found that the milk houses which were attached to the barn were in general

warmer than the one located apart from the barn. The proportion of days with freezing temperatures was less and the heat necessary to prevent freezing was considerably less.

By having one wall common to the barn and the milk house, some heat is obtained from the barn. The milk house will be protected in many instances from the wind.

SUGGESTED LOCATIONS FOR A MILK HOUSE

The study revealed that the locations shown in Fig. 4 are common in Michigan. The locations shown inside of the barn and the locations

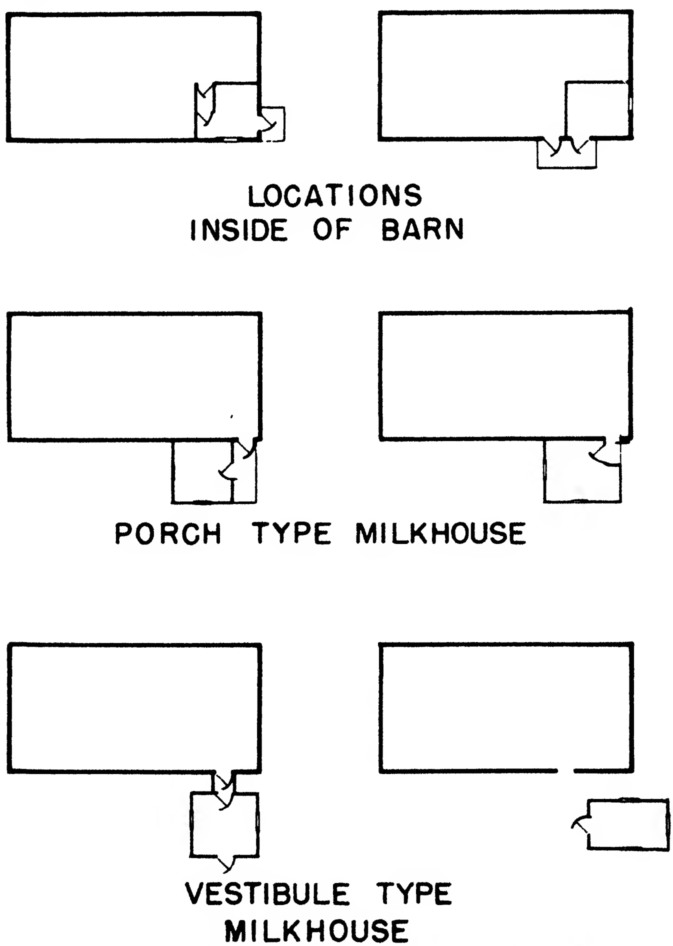

Fig. 4. Recommended locations for milk houses in Michigan.

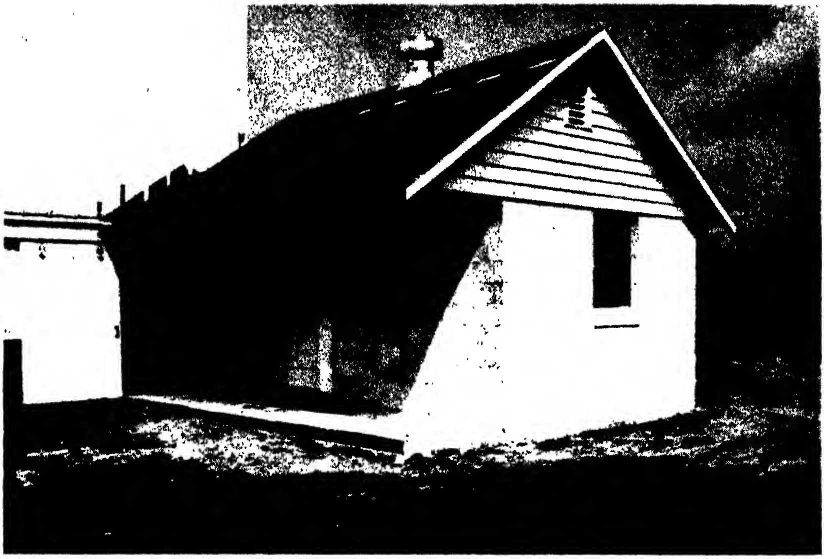

Fig. 5. Experimental milk house, Michigan State College.

showing the porch-type milk house are recommended to make the milk house functional the year around.

Figure 5 shows a milk house built close to the barn and located so that milk can be easily taken from the stable to the milk house for straining and cooling. Figure 6 shows the plan for a Type-A Milk House which will be approved by all of the city ordinances studied. This plan allows sufficient room for the necessary operations and equipment for the production of quality milk. Other types of milk houses can also be used and plans are available for the various types of milk houses.

CONCLUSIONS

1. A milk house is a structure which, if properly used, will save time and labor on a dairy farm and will make the production of high quality milk easier.

2. The equipment recommended as essential in a milk house includes:

a. A milk cooler
b. A wash vat (double)
c. A water heater
d. A can rack

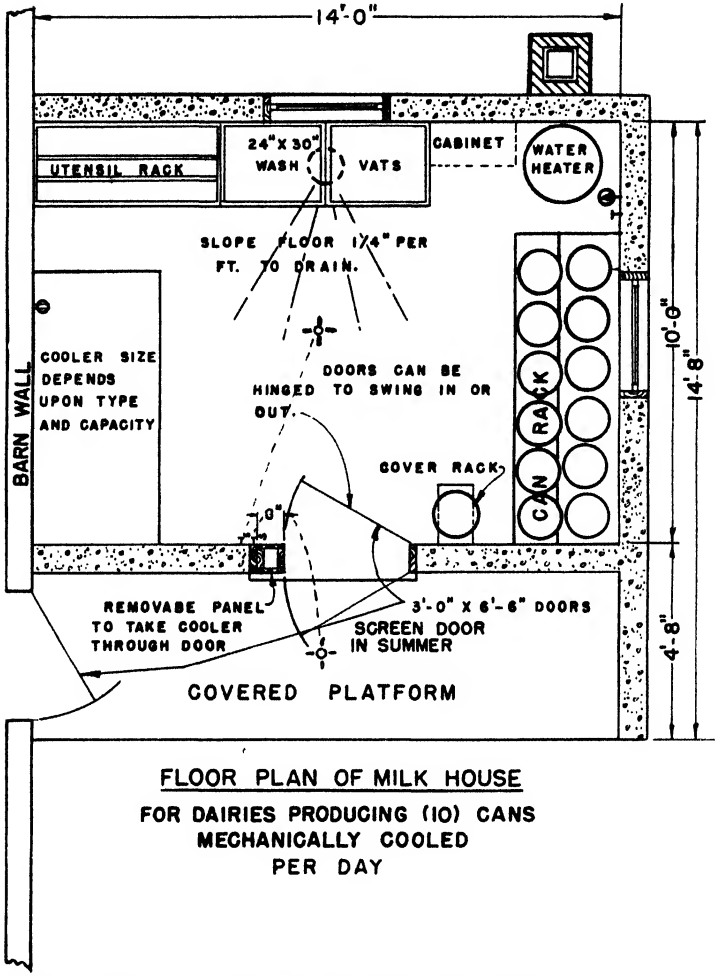

Fig. 6. Plan for a type "A" milk house approved by the 12 major milk markets in Michigan.

3. The floor area requirements of a milk house depend on the size of herd and should not be large enough to allow trash to accumulate. A farmer producing six to eight cans of milk daily should have a minimum of 100 square feet in the milk house.

4. The milk house should be located as close to the barn as possible. Locating the milk house in the barn is desirable providing:

a. There is no direct opening to stable.

b. A tight wall is constructed between the milk house and stable.

c. The location will be approved by the inspector buying the milk.

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PROTECTION OF TOMATOES FROM FROST DAMAGE BY USE OF RADIANT ENERGY

By C. M. HANSEN[1] *and A. W. FARRALL*[2]

ON JANUARY 1, 1948, the Agricultural Engineering Department of Michigan State College, turned over to the industry for manufacture, complete drawings of an infrared, radiant-type frost control machine, and demonstrated a full-size model. Much research had been done to determine the scope of this machine prior to releasing it for manufacture.[3 and 4] The working model represented two and one-half years of research. Since that time, many units have been manufactured. Many were used in a preliminary field test program during the spring of 1948, under a wide range of conditions, in nine of the eastern and middle western states. Results of these tests were very encouraging. Much of the data obtained from the field tests were of a rather general nature, and it was desirable to obtain further accurate and complete information regarding the performance of these machines. In order to carry out this program, a group of three of the commercially manufactured units were set up and operated in a tomato field on the College farm during the fall of 1948.

OBJECT OF THE TESTS

The principal objectives of the tests were 1) to obtain accurate information relative to the temperature at which protection from frost damage could be obtained under field conditions; 2) to determine the fuel cost per machine, per hour; 3) to determine the number of days the growing season would be extended through the use of these machines; and 4) to study the general operating characteristics of the machines.

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[2]Head, Agricultural Engineering Department.

[3]Hassler, F. J., Hansen, C. M., and Farrall, A. W. Protection of Vegetation from Frost Damage by Use of Infrared Energy. Mich. Agr. Exp. Sta. Quart. Bull., *30* (3): 339-360. 1948.

[4]Acknowledgment is made of the interest and valuable assistance of the Detroit Board of Commerce, Agriculture Research Committee, in connection with this project.

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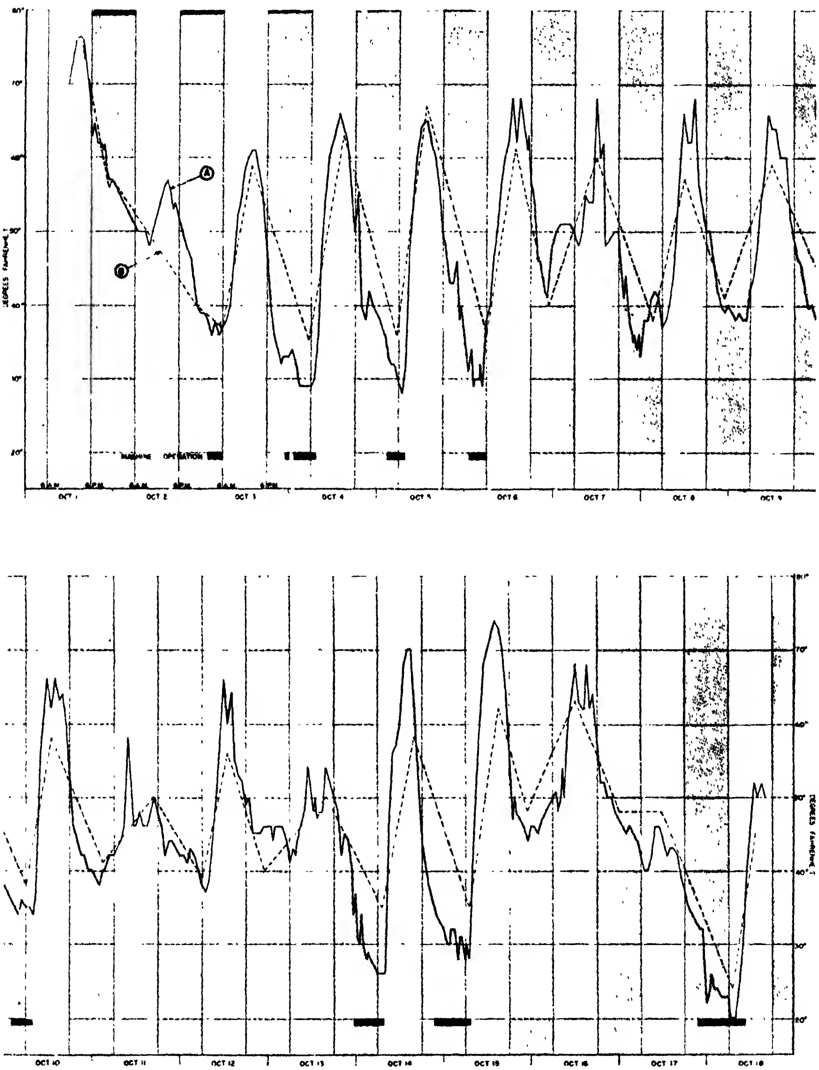

Fig. 1. Log of frost prevention test, fall 1948. "A"—actual temperature in degrees Fahrenheit. "B"—maximum and minimum Weather Bureau temperatures in degrees Fahrenheit.

PROCEDURE FOR TESTING

Three of the radiant-type frost prevention machines were placed in a field having rolling terrain of sandy loam. The field had been planted to a Georgia-grown variety of Stokesdale tomatoes on May 29 and 31, 1948.

The machines were installed on a triangular pattern, having sides of 130 feet, 128 feet, and 100 feet, respectively, in order to study the effect of the different intensities of infrared radiation on the crop. Data secured from previous tests, showed that this installation would give a radiation intensity of not less than 80 microvolts, or 2.65 watts per square foot, to an area of 1.2 acres (Fig. 2). Between units "A" and "B", the intensities were not less than 9.93 watts per square foot. while there was not less than 5.96 and 5.87 watts per square foot between units "B" and "C", and units "A" and "C", respectively.

TEMPERATURE MEASUREMENTS

It was necessary to make a thermo-survey of both the adjacent and surrounding areas, to determine a suitable location, beyond the infrared influence, which would give a true temperature reading of the protected area. Mercury thermometers were calibrated and suspended with the bulb 1 inch above the ground, at various locations. Readings were made under a series of nocturnal conditions. From these readings, a location 400 feet from the frost prevention units was selected which gave a thermo-response the same as in the area adjacent to the machines when they were not in operation. The temperature readings of the two locations had no significant statistical difference.

The recording thermometer which was used, had an exterior coil-type sensitive bulb. This bulb was supported 1 inch above the ground. A mercury thermometer was used to check the accuracy of this unit periodically throughout the course of the experiment. Since the nocturnal readings were of major interest, no attempt was made to shade the sensitive bulb from the sun.

FROST CONTROL OPERATION

The machines were installed in the tomato field on September 20, and checked for mechanical deficiencies. It was determined that the machines were to be turned on when the temperature dropped

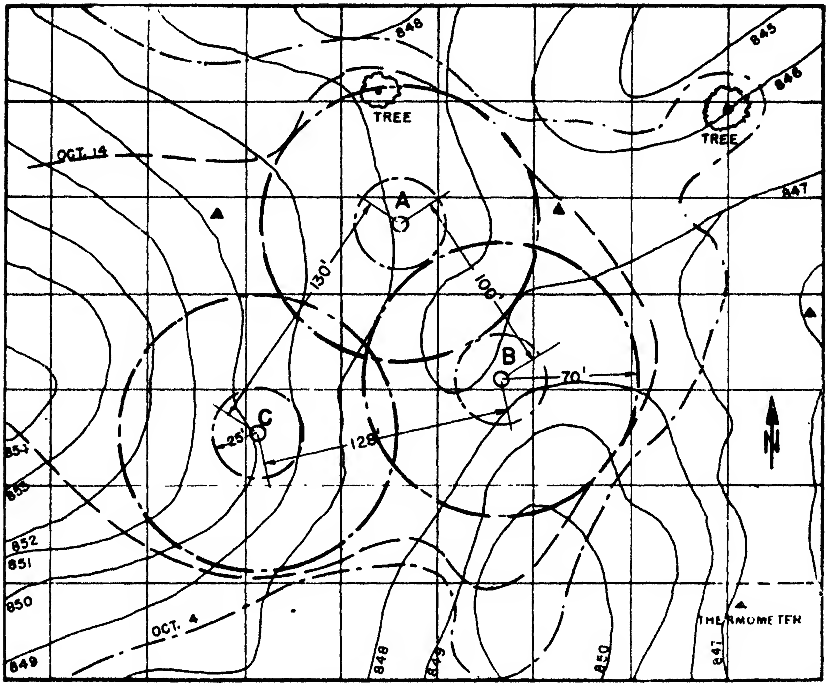

Fig. 2. Location of machines and frost lines on different dates.

to 34° F. They were operated for 4 hours on the night of October 2 as a preliminary operational check (Fig. 1). On the night of October 3, the machines were started at 11:00 o'clock and were operated for one hour; at 1:00 a. m., they were again turned on and operated continuously until 7:20 a.m. October 4 (Fig. 1). On the morning of October 4, the tomatoes beyond the infrared influence were frosted for the first time, to a line indicated on the map (Fig. 2). The line is not definitely defined but is, rather, a band about 12 feet wide. beyond which, all plants were frozen. The walnut trees near the machines, and the topography did influence the frost line; yet, frost occurred at a higher elevation than the area covered by the machines. On this date, the lowest recorded temperature was 29° F. The temperature on the following night dropped momentarily to 28° F., but no further damage was noted.

During the nights of October 4, 5, and 6, the temperature dropped

below 32° F. (Fig. 1), and on each night, the machines were operated for several hours. The temperatures were as follows:

Date	*Time Below 32° F.*	*Min. Temp. in ° F.*
Night of October 4	5 hr., 15 min.	29
Night of October 5.	3 hr.	28
Night of October 6	4 hr.	29

At the end of this period, there was no evidence of change in the frost line established on October 4. No further frosts occurred until the night of October 13.

Cold winds on October 13 caused the temperature to drop, and the machines were started at 12 midnight and operated for 8 hours. The temperature was below 32° F. for a total of 7½ hours. It dropped to 26° F. at 6:00 a.m. and remained there for a 2-hour period. Heavy fog accompanied the frost; yet, at no time, was there any within the area of the machines. The topography again influenced the frost line, but the trees no longer assisted in warding off damage to the plants near them.

This same cold wave extended through the night of October 14, when the temperature dropped below 32° F. for 7 hours, with a minimum of 28° F. The machines were operated for 9½ hours.

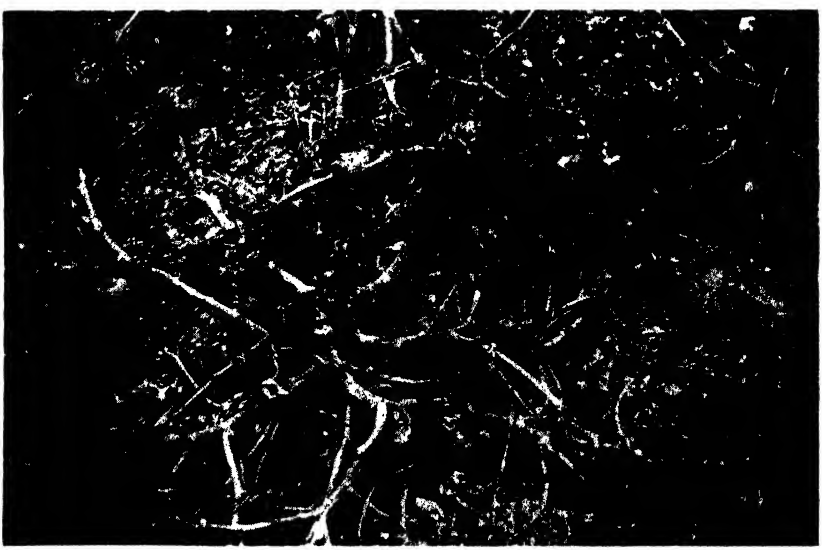

Fig. 3. Appearance of a tomato plant on October 15 at a point 120 feet from a frost prevention unit, and out of the effective range. Note that the plant has been destroyed by the several frosts which had occurred.

Fig. 4. Photograph of plants on October 15 at a point 70 feet from one unit and 90 feet from another, showing that the leaves and blossoms had not yet been injured by a series of frosts, the lowest of which reached a temperature of 26° F.

Examination of the tomatoes, during the afternoon of October 15, (Figs. 3 and 4) showed complete protection of the plants within a radius of 70 feet from a single machine. The intensity of radiation at this distance was 2.65 watts per square foot, as measured at right angles to the radiation with an Eppley radiation meter. This indicates that the machines could well have been located at greater distances apart, thereby protecting a much greater area. They were so close together that the radiation intensity between units "A" and "B", for example, was 9.93 watts per square foot or greater. An intensity of only 2.65 watts was needed to give ample protection against the 26° F. temperature.

The tomatoes on a hill, west of the machines, were not severely damaged, owing to the difference in elevation. It was noted that there was much white frost on the dead stems and leaves throughout this hill area.

The temperature, on October 17, did not go above 48° F, because there was a "cold front" moving in from the northwest. At about 5:30 p.m., the sky cleared and the temperature progressed steadily down. At 8:00 p.m., the machines were started and operated for 12½

hours. The cool wind, which was never less than 8 m.p.h., carried away more heat from the stems of the plants than could be replaced by infrared energy. The temperature dropped, on the morning of October 18, to 20° F., and remained there for 2 hours. The lowest temperature recorded by the Weather Bureau was 24° F. This reading was taken approximately one and one-half miles distant. The cold front freeze caused a sharp demarcation of the injured and uninjured plants at a radius of 25 feet from the machines.

INFLUENCE OF LOCATION OF THERMOMETER UPON TEMPERATURE READINGS

One of the most important facts, again emphasized by this experiment, was that the temperature, as given by the local Weather Bureau, may be several degrees warmer than that which actually exists on a given field (Fig. 1). For example, on the night of October 3, the Weather Bureau reported a low of 35° F., while on that same night tomatoes which were not under the influence of the machines, were destroyed by frost. Temperature recorded in the field, showed a minimum of 29° F. for a 4-hour period. This is of extreme practical importance because it proves that temperatures for truck crops and other low-growing vegetation must be taken in the field and at a point near the ground. In this experiment, temperature readings were always taken at a point one inch above the ground, with exposed thermometers. If dependence had been placed upon temperature readings taken at an elevation, and under conditions comparable to those of the Weather Bureau, or if regular Weather Bureau readings had been relied upon for determining when to start the frost prevention machines, the tomatoes would have all been completely destroyed. This difference in readings is greater during radiation frosts when no appreciable air movement prevails.

DATES OF FIRST KILLING FROSTS IN MICHIGAN

Usually, there are a number of light frosts which precede the first killing freeze. The fall of 1948 was no exception and, owing to the use of the radiant-type frost prevention units, the growing season of the tomatoes in the protected area was lengthened by 13 days. Normally, the light frosts occur in September and the number of days of lengthened growing season would be much more than this.

On October 18, 1948, the growing season in the vicinity of Lansing, Michigan, was terminated by a wind-borne freeze in which the Weather Bureau temperature was recorded as 24° F., but in which readings at one inch above the ground in the tomato field, showed a temperature of 20° F. It is significant that the killing frosts, as noted by the East Lansing Weather Bureau for the past 12 years, show that in only one year since 1937, has the temperature dropped to 26° F. or below. Usually, it was at 28° to 32° F. (Fig. 5). In all of these instances, it is expected that the frost prevention machines would have given a good measure of protection of tomatoes even against the so-called "killing" frost.

Year	Day of Month		° F.
1937	October	13	26
1938	"	7	28
1939	"	1	28
1940	"	16	30
1941	"	27	32
1942	Sept.	29	29
1943	October	30	33
1944	"	15	27
1945	"	3	32
1946	"	1	32
1947	Sept.	26	32
1948	October	18	24

Fig. 5. Date and temperature of first killing-frost for the past 12 years.

FUEL CONSIDERATIONS

Some difficulty was encountered in the operation of the three 1947-model frost-prevention machines when they were checked for field testing. Inasmuch as the kerosene was stored in a closed container since the spring of 1948, it was felt that the erratic operation might be due to some mechanical irregularity. The burners were cleaned, and the pumps were checked and found to be in excellent condition. Further investigation showed that fuel obtained recently from a distributor made the machines operate properly.

In view of the methods of refining, normally employed in the production of kerosene, it is highly improbable that any appreciable deterioration will occur, even over prolonged periods of storage. Unless

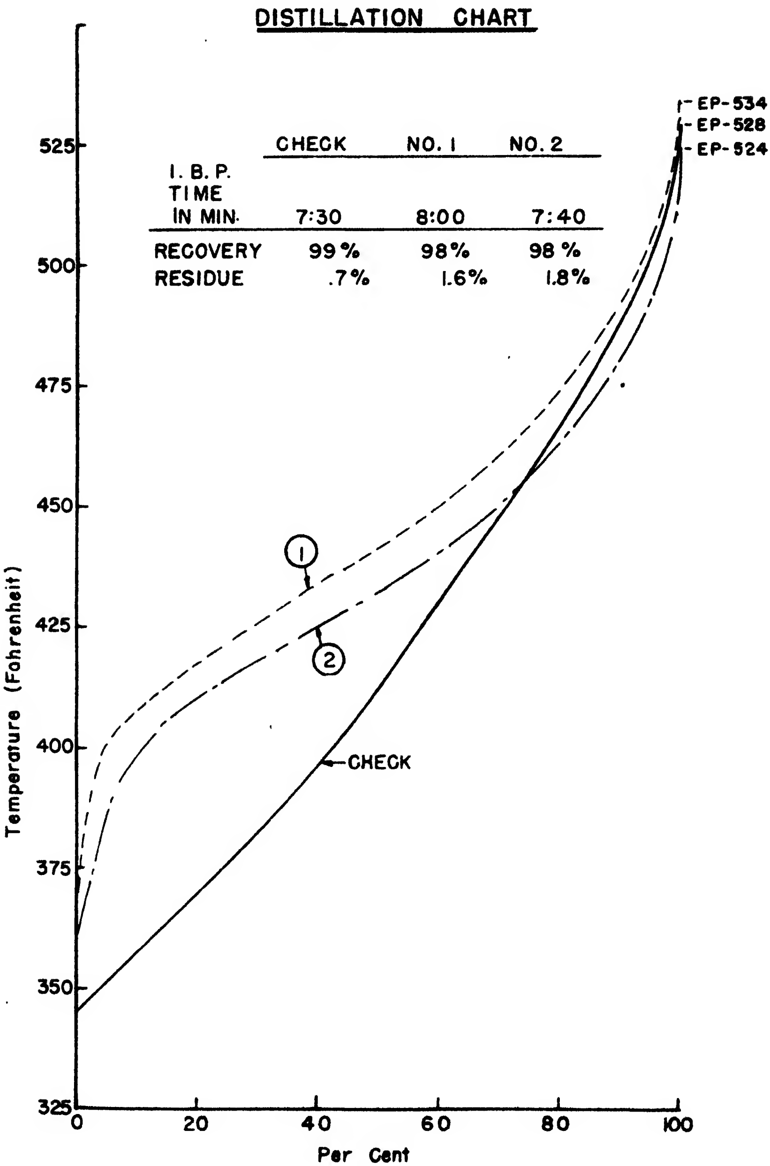

Fig. 6. Distillation chart.

the containers are properly closed, however, it is possible for some of the volatile fractions to be lost, owing to "weathering".

A distillation test was made, and it was found that the volatility of the fuels which would not burn properly, had been seriously affected (Fig. 6). The initial boiling points (IBP) of the fuels No. 1 and 2 (both poor burning), which were held over from April 1948, were 23° and 17° F. higher, respectively, than the checked fuel which burned satisfactorily. The distillation temperatures of No. 1 and 2 fuels remained higher until they reached the 85- and 72-percent marks, respectively. It is interesting to note that these fuels have distillation characteristics which approach those of the A.S.T.M. standards. The IBP time, in this case, is of no significance. End points (EP) of all the fuels tested had a spread of only 10° F., with the No. 2 fuel being less than that of the check. The fact that distillation lines of the No. 1 and No. 2 fuels cross the check at the 72- and 85-percent mark, indicates that this does not have a bearing on proper burning characteristics.

The "light ends" are most important to successful burning in the frost prevention machine. Satisfactory kerosene, for this purpose, should have a maximum 10 percent distillation point of 355° to 360° F., and the 50 percent point should be 415° to 420° F.

STORAGE OF KEROSENE

It is quite evident that the kerosene which is to be used in these frost prevention machines must be stored in a cool place and in a closed container. If 50-gallon drums are to be used successfully, space must be left for expansion of the fuel. This can be easily accomplished by putting only 45 gallons into the drums.

COST OF OPERATION

Accurate records of fuel consumption were kept covering the various tests. It was found that, for a total of 53½ hours of operation, the average hourly consumption of kerosene was 10.8 gallons per machine. With this information, and the fact that a radiation intensity of 2.65 watts per square foot protected tomatoes against 26° F. temperatures, it is possible to calculate, closely, the cost of fuel per acre. When the units are operated in groups of three or more, in order to take advantage of the overlapping radiation from different directions, the maximum efficiency will be obtained.

SUMMARY

During this series of tests, tomatoes under field conditions were successfully protected against damage from a radiation-type frost when the temperature at one inch above the ground was 26° F., outside of the protected area.

Tests also showed that a radiation intensity of 2.65 watts per square foot was necessary to give adequate protection at 26° F., the intensity being measured at right angles to the direction of radiation.

Fuel consumption of the radiant-type, infrared, frost-prevention unit was 10.8 gallons of kerosene per hour.

Kerosene fuel, for these units, must meet a certain standard of volatility.

Temperature measurements must be made *in the field to be protected,* when determining the time to start the radiation units. All thermometers must be exposed to the atmosphere. Weather Bureau or other readings, taken at a distance, do not give a true indication of the temperature condition in a given field.

RESULTS OF IRRIGATION ON VEGETABLE CROPS

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SECTIONS OF AGRICULTURAL ENGINEERING AND HORTICULTURE

TESTS WERE conducted during 1948 to determine the effect of different amounts and times of irrigation on the yields of the following vegetable crops:

Snap beans (Stringless Green Pod and Brittle Wax)
Tomatoes (Stokesdale and Wisconsin 55)
Sweet corn (Golden Cross Bantam and Erie)

The crops were grown near East Lansing on a Hillsdale sandy loam soil which was rather low in fertility. A pre-planting application of 800 pounds per acre of 3-12-12 fertilizer was drilled over the entire area. Water used for irrigation was pumped from a stream adjacent to the field.

Quick-coupling portable pipe carried the water to the plots, and it was applied through a group of fixed type sprinklers attached to

Fig. 1. Irrigation of plots with fixed-type sprinklers.

ARTICLE 31-38

a supply line supported on stands in the middle of each plot. A combination of full, quarter and half-circle sprinklers were used to obtain uniform distribution of water. Fig. 1 shows some of the plots being irrigated. This particular type of equipment was selected because of its adaptability to plot work, and would not be recommended for farm use. In the irrigation of vegetable crops produced commercially in Michigan, quick-coupling portable pipe is being installed either with revolving sprinklers or perforations. Fig. 2 shows a typical system in operation.

TREATMENTS

The following irrigation practices were compared:

1. Unirrigated.

2. Irrigation when needed, as determined by gypsum moisture blocks placed at 4 and 8 inches in the soil.

3. One inch per week whenever the rainfall for the previous week did not total one inch.

4. One and one-half inches per week whenever the rainfall was less than 1½ inches during the previous week.

Irrigation for treatment 2 was begun when the blocks showed that available moisture in the soil was less than 50 percent.

Treatments were randomized in 15- by 35-foot plots, with three replications. Ten-foot alleys were left between each replication of plots.

Fig. 2. Irrigation of potatoes with portable pipe sprinkler equipment.

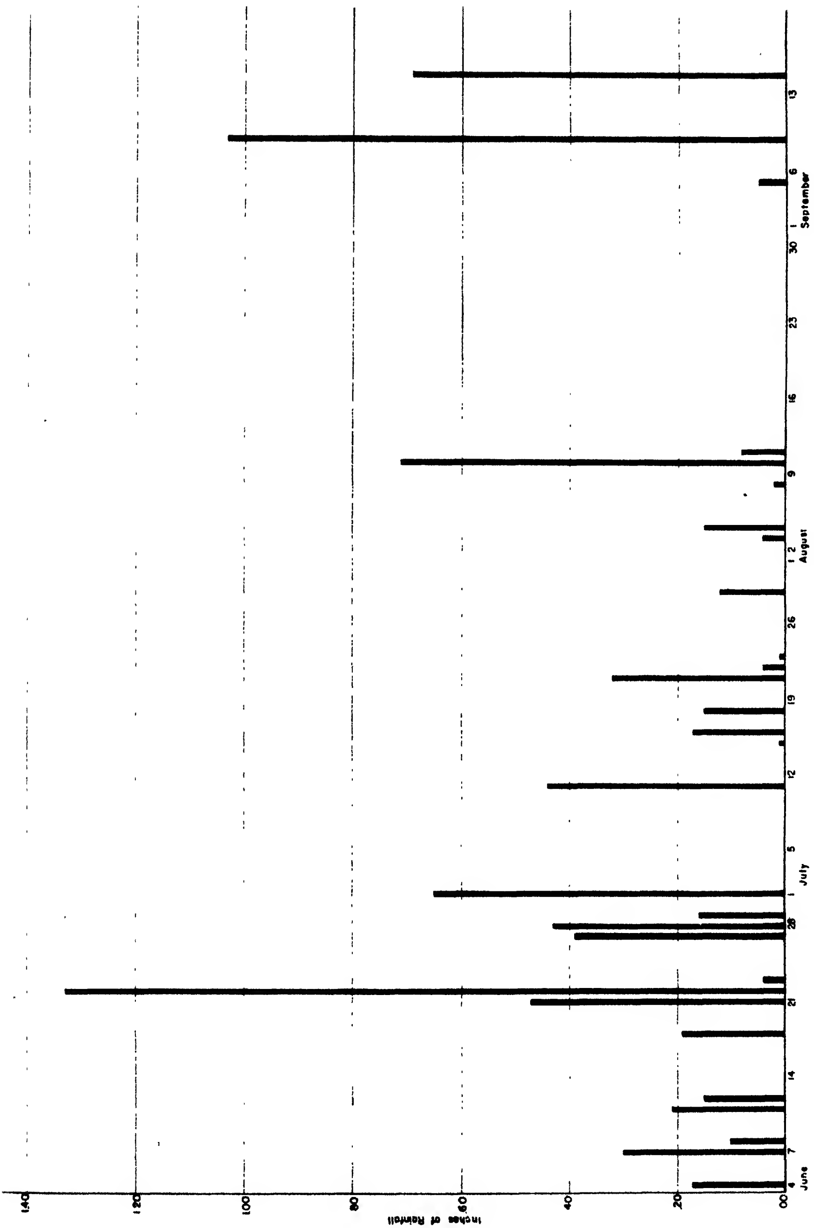

Fig. 3. Rainfall on irrigation test plots, Okemos, Michigan, 1948.

TABLE 1—*Rainfall on irrigation test plots, Okemos, Michigan, 1948*

Date	Amount in inches	Date	Amount in inches
June 4	0.17	July 16	0.17
June 7	0.30	July 18	0.15
June 8	0.10	July 20	T
June 11	0.21	July 21	0.32
June 12	0.15	July 22	0.04
June 18	0.19	July 25	0.01
June 21	0.47	July 27	T
June 22	1.33	July 29	0.12
June 23	0.04	August 3	0.04
June 27	0.39	August 4	0.15
June 28	0.43	August 8	0.02
June 29	0.16	August 10	0.71
July 1	0.65	August 11	0.08
July 10	T	September 5	0.05
July 11	0.44	September 9	1.03
July 15	0.01	September 15	0.69
		Total for season	8.62 inches

WEATHER CONDITIONS

Table 1 and Fig. 3 show the rainfall during the growing season, June 1 to September 15. The rainfall in this three and one-half month period was 8.62 inches as compared with an average for this area of 10.93 inches.

It can be seen that there were two rather long periods in which there was no rain. The first was for 10 days from July 1 to 11. The second was of 25 days duration from August 11 to September 5, which was particularly injurious to the unirrigated corn and to several other crops such as melons and cucumbers grown in the area.

During the rest of the season the rainfall was well distributed, however there was a deficiency in moisture during the latter half of July and first week in August. There was rain on 10 different days, but in every case it was very light.

RESULTS

Snap Beans

The Stringless Green Pod and the Brittle Wax varieties of snap beans planted June 1 were in adjacent rows. The stand of the wax beans was satisfactory but that of the Green Pod was quite broken which probably influenced the yields obtained with the various irrigation treatments. The first picking was made August 1.

TABLE 2—*Results with snap beans*

Treatment	1 Unirrigated	2 By blocks	3 1" per wk.	4 1½" per wk.
Water applied	....	2"	8"	15½"
		Brittle Wax		
Yield in lb./acre	4,124	5,842	6,390	6,888
Percent increase in yield	....	41	55	67
Net value of increase per acre*	....	$28.90	$30.15	$34.71
		Stringless Green Pod		
Yield in lb./acre	4,066	3,925	5,311	5,029
Percent increase in yield	....	—3.5	31	24
Net value of increase per acre*	....	—$23.15 loss	$1.56	—$15.72 loss

*The cost of applying water includes depreciation and repairs on equipment, interest on investment, cost of power and labor for irrigation.

Canner's price for beans—5c per pound.

Cost of picking and marketing the increased yield—2.2c per pound.

In Table 2, the data indicate that for wax beans an application of as little as 2 inches of water increased the yield 41 percent . With 6 inches additional water the yield was increased an additional 14 percent. The Brittle Wax variety shows the most profitable increase per inch of water, with the total application of only 2 inches. Because of the broken stand, the results on the green beans are too variable to be reliable.

Tomatoes

Plants of the Wisconsin 55 and Stokesdale varieties of tomatoes were set May 31 in irrigated soil. As a result of sufficient moisture very little replanting was necessary. Harvesting extended from August 24 to October 1.

Climatic conditions were quite favorable and resulted in high tomato yields in this general area. The data in Table 3 indicate that in both varieties the plants receiving 4 inches of irrigation water during the season produced larger increases in total weight than others receiving three to four times as much water. In the Wisconsin 55 variety the application of 4 inches of water resulted in 63 percent increase in total weight; with the Stokesdale variety the same treatment produced an increase of 69 percent in total weight.

The number and weight of fruit on plots receiving either 11 or 16 inches of water were substantially lower than those on plots receiving 4 inches of water. In this experiment the heavy irrigations resulted in

TABLE 3—*Results with tomatoes*

Treatment	Water applied	Yield			Net value of increase per acre*
		Bushels (acre)	Number of tomatoes (thousand/acre)	Average weight of fruit	
WISCONSIN 55					
1 (unirrigated)	....	472	86.8	.33	....
2 (by blocks)	4″	771 +63%**	121.0 +39%	.38 +15%	$245.20
3 (1″ per week)	11″	585 +24%	92.9 + 7%	.38 +15%	61.35
4 (1½″ per week)	16″	597 +26%	93.7 + 8%	.38 +15%	67.90
STOKESDALE					
1 (unirrigated)	....	529	89.9	.36	....
2 (by blocks)	4″	895 +69%	133.5 +49%	.40 +11%	$305.50
3 (1″ per week)	11″	682 +29%	103.4 +15%	.40 +11%	97.35
4 (1½″ per week)	16″	681 +29%	108.5 +21%	.38 +5.6%	92.20

*The cost of applying water includes depreciation and repairs on equipment, interest on investment, cost of power and labor for irrigation.

Fresh market price for tomatoes—$1.50 per bushel. Cost of picking and marketing the increased yield—60c per bushel.

**Percentages are increases in yield as compared with the yield of unirrigated plants.

a lower fruit set. The size of fruit was increased up to 15 percent by irrigation and was not influenced by the amount of water applied.

The data show that irrigation was very profitable on tomatoes.

Sweet Corn

Two varieties of sweet corn, Erie and Golden Cross Bantam, were drilled in 3-foot rows on June 1. The plants were thinned to an average stand of 132 stalks per hundred feet of row.

During the latter part of August, the unirrigated corn showed the effects of drought by the rolled leaves and a difference of about 12 inches in height. The corn was picked on August 30 and September 5.

The corn was weighed and counted. The data in Table 4 show the average weight per ear, the total weight, and dozens of harvested and marketable ears to the acre.

Corn was benefited more by irrigation than either of the other

TABLE 4—*Results with sweet corn*

ERIE

Treatment	Water applied	Dozens of ears per acre harvested	Dozens of ears per acre marketable	Percent market-able	Tons per acre harvested	Average weight of ear	Net value of increase per acre*
1 (unirrigated)......	.....	1126	363	32.2	2.77	.41	....
2 (by blocks).......	4"	1516 +34%**	1297 +257%	85.6	5.82 +110%	.64 +56%	$162.90
3 (1" per week)......	8"	1354 +20%	1163 +221%	85.9	5.20 +88%	.64 +56%	$126.70
4 (1½" per week)...	14½"	957 −1.5%	793 +118%	82.9	3.10 +12%	.54 +32%	$44.18

GOLDEN CROSS BANTAM

Treatment	Water applied	Dozens of ears per acre harvested	Dozens of ears per acre marketable	Percent market-able	Tons per acre harvested	Average weight of ear	Net value of increase per acre*
1 (unirrigated)......	.....	1208	229	19.0	2.61	.36	....
2 (by blocks).......	4"	2026 +68%	1668 +628%	82.3	6.32 +142%	.52 +44%	$263.90
3 (1" per week)......	8"	1539 +27%	1237 +440%	80.4	4.71 +80%	.51 +42%	$168.30
4 (1½" per week)....	14½"	1189 −1.6%	699 +205%	58.8	2.71 +3.8%	.38 +6%	$52.18

*Cost of applying water includes depreciation and repairs on equipment, interest on investment, cost of power and labor for irrigation. Fresh market price for corn—30 cents per dozen ears. Cost of picking and marketing the increased yield—10 cents per dozen ears.

**Percentages are increases in yield as compared with the yield of unirrigated plots.

crops. An increase of 257 percent in the number of dozens of marketable ears of Erie variety resulted from the application of 4 inches of water.

In the Golden Cross variety a similar application of water resulted in an increase of 628 percent. This variety had less than 20 percent of the ears marketable on the unirrigated plots while on the irrigated plots over 80 percent of the ears were marketable. The Erie variety produced 32 percent marketable ears on the unirrigated area, while irrigation increased the marketable ears to 85 percent. These facts indicate that Golden Cross was benefited more by irrigation than Erie. In practice it has been frequently observed that Golden Cross fills very poorly under drought conditions.

Weight per ear was increased 56 percent in Erie and 44 percent in Golden Cross by an application of 4 inches of water. This increased size was due to a longer, better filled ear resulting in better market quality.

CONCLUSIONS

The results of these tests indicate that irrigation in a year of subnormal rainfall during the growing season is a very profitable practice on vegetable crops. Even in years of normal rainfall there are frequently drought periods of sufficient duration to warrant the investment in irrigation equipment.

Under the conditions of this experiment, increased quantities of irrigation water did not result in proportionate increases in yields. In some cases yields decreased with the larger quantities of water.

It was found that sweet corn showed the greatest response to irrigation, with tomatoes and snap beans following in the order named.

The data reported are based on one year's results on a Hillsdale sandy loam soil. Under other conditions the response to irrigation would probably vary considerably. Further investigations of the interrelationship of vegetable crops, soils and irrigation practices under varying seasonal climatic conditions are warranted.

LOSS OF COWS FROM DAIRY HERDS REDUCES INCOME

By *RUSSELL E. HORWOOD*
SECTION OF DAIRYING

DAIRYING PROVIDES the largest source of income for the Michigan farmer. The production of the state's farm dairy herds accounts for about one-third of the cash income of Michigan farmers. Sale of animals from the dairy herds adds materially to this income. Michigan dairymen now keep approximately 900,000 cows on 150,000 farms.

Dairymen in many cases are not aware of the seriousness of the cow losses in their herds. This is due to a lack of records of the number and causes of cow removal from their herds. The income from the sale of products and cattle could be increased markedly if the losses of dairy cattle could be reduced.

Studies have indicated that replacement rates in dairy herds are high. Investigations by Lush and Lacy (4), McDowell (5), and Smith and Robinson (6) show it is necessary to replace approximately 21 to 28 percent of the milking herd annually. Cannon and Hansen (2) report that 56 percent of all animals in cow testing associations in Iowa were under 5 years of age.

Baltzer (1) reports that a study of Dairy Herd Improvement Associations figures covering six years from 1931 to 1937 reveals that the average milk-producing life of a cow, if all factors are included, is about 3.7 to 4 years. The data indicate that a dairyman must plan to reproduce his milking herd every 4 years.

Lush and Lacy (4) found, from a study of 500 cows in each of the dairy breeds, the productive life of a cow to be 3 to 5 years.

In Iowa (3), it is reported that 26.2 percent of all cows in Dairy Herd Improvement Associations test in that state left the herd annually. Approximately one-third of this number left the herds because of low production, one-third for health reasons and one-third were sold for dairy purposes.

ARTICLE 31-39

TABLE 1—*The number and cause of removal of cows by breeds from the College and Sub-station herds during the period 1933-41*

Breed	Reasons for cow removal										Total removed	Total in herd
	Dairy purposes	Low production	Breeding troubles	Mastitis	Bangs and abortion	Loss at calving	To experimental herd	Old age	Udder injuries	Miscellaneous		
College Ayrshire	7	14	3	10	.....	.....	.....	.....	1	1	36	42
College Brown Swiss	3	2	2	4	.	1	3	.....	.....	3	18	31
College Guernsey	9	5	11	4	1	...	1	.....	1	2	34	48
Kellogg Guernsey	3	15	8	7	3	1	. .	2	.....	3	42	96
College Holsteins	15	8	12	16	3	2	10	.....	2	4	72	84
Chatham Holsteins	32	10	5	3	.....	1	.....	.....	1	5	57	75
College Jerseys	16	12	5	6	1	2	4	2	.....	5	53	62
TOTAL	85	66	46	50	8	7	18	4	5	23	312	438
Percent of those removed	27.2	21.1	14.7	16.0	2.6	2.2	5.8	1.3	1.6	7.4	100	....
Percent of total cows removed	19.2	15.1	10.5	11.4	1.8	1.6	4.1	0.9	1.1	5.3	71.0	.....

PROCEDURE

A study was made in the Michigan State College herds covering a period of nine years from 1933 through 1941 to determine the number and cause of dairy cow removal.

The herds consisted of the W. K. Kellogg Sub-station herd at Augusta, made up of the Guernsey breed; the Upper Peninsula Experimental Station, made up of the Holstein breed; and the Michigan State College herd which includes the Ayrshire, Brown Swiss, Guernsey, Holstein, and Jersey breeds. See Table 1.

The greatest cause of removal was the sale of cows for dairy purposes. This amounted to 19.2 percent of the total, or 85 of the 438 cows that had freshened. This is 27.2 percent of those removed. Sale for dairy purposes is not considered a loss to the herd.

Each cow removed from the herd for other than dairy purposes normally leaves at a loss to the owner. In case of death this is nearly a complete loss. In other instances the value for beef may be all that

is retained. In some cases the loss may be sufficiently great to require the purchase of outside cattle to maintain the herd.

The greatest cause of loss in this study was due to low production. This agrees with the previous studies cited. Sixty-six animals, or 15.1 percent of the total, were removed for this reason. Another primary reason for removal was disease. Mastitis proved to be the greatest factor. In all, 50 animals, or 11.4 percent, were slaughtered as a result of udder infection.

Breeding trouble was found to be nearly equally important and resulted in 46, or 10.5 percent, being eliminated. Minor losses include 8 cows, or 1.8 percent, being removed because of Bang's disease and abortions and 7 cows, or 1.6 percent, died at calving time. Other causes as udder injuries, old age, bloat, and miscellaneous reasons totaled 11.4 percent. The percentage of the cows removed for each cause is shown in Table 1.

From the data presented it is evident that it is important to reduce the losses of cows from dairy herds. Modern methods of dairying which include the latest developments in breeding, feeding, management and disease should aid in accomplishing this.

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TRANSMISSION THROUGH GRAFT UNIONS OF FORMATIVE STIMULI INDUCED BY 2, 4-DICHLOROPHENOXYACETIC ACID

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SECTION OF HORTICULTURE

THE MECHANISM by which 2, 4-dichlorophenoxyacetic acid (abbreviated: 2, 4-D) acts and produces morphological responses in plants is yet unknown. Skoog (2), citing Guttenberg's hypothesis on the mode of action of growth regulators, has suggested the possibility that the release of native-bound auxin in plants treated with synthetic growth regulators like 2, 4-D may result in an excess of free auxins which causes the physiological and morphological disturbances. However, convincing proof is still lacking. Morphological changes as a result of the application of phenoxy compounds have been studied by Zimmerman and Hitchcock (5) and by others. With their similarity to virus manifestations and phenomena associated with induced chromosomal disturbances (3), they have been of interest ever since their first observation. The primary object of the present investigation was to follow up accidental leads which indicated a peculiar mode of transmission through graft unions of stimuli such as produced by the treatment with 2, 4-D and expressed by morphological abnormalities.

EXPERIMENTATION

The tomato, which is highly sensitive to the action of 2, 4-D, was selected for the purpose of this study. Plants of the John Baer variety, 5 weeks old and 30-40 cm. high, were treated by immersing their third basal leaf in a 1000 p.p.m. aqueous solution of sodium 2, 4-dichlorophenoxyacetate during the first week of November 1947; the customary precautions were taken to prevent contamination of other parts of the plants. After displaying the usual nastic effects all plants developed malformations on their terminal parts. Three weeks after the treatment when these effects were well established, reciprocal grafts were made with untreated plants; the method of splice grafting was used.

ARTICLE 31-40

Controls included untreated scions grafted on untreated stocks and scions from 2, 4-D treated plants on 2, 4-D treated stocks. Twelve grafts of each group were made. Unions were found established within 7-10 days. Axillary shoots were not allowed to develop on the stock during this period, and for two weeks afterwards. However, subsequently the plants were allowed to grow without being disturbed.

Three months after grafting the symptoms evident on the plants were recorded. Quantitatively, there were considerable differences between the responses of the individual plants. Qualitatively, however, definite trends were noticed. Typical plants of each group are shown in Fig. 1.

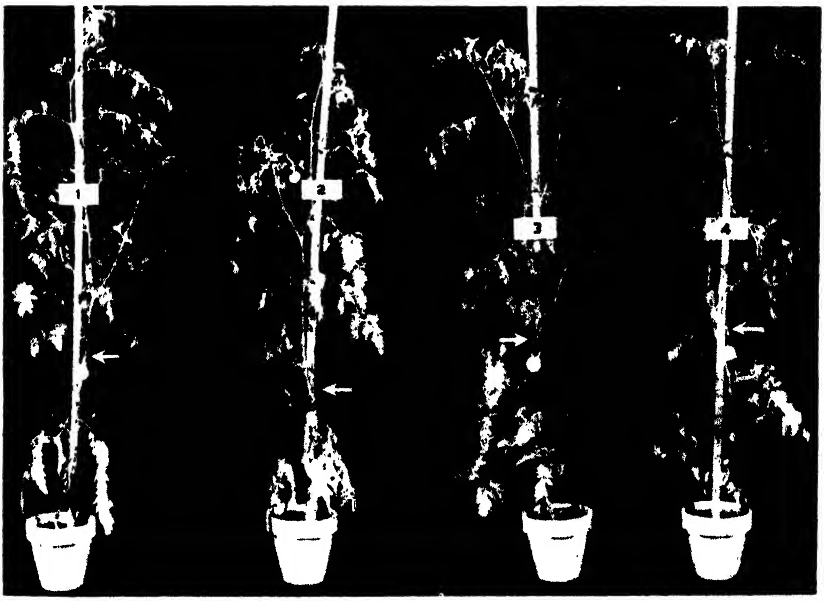

Fig. 1. Typical plants of four different graft combinations.
1: Untreated plant grafted on untreated plant
2: Treated plant grafted on treated plant
3: Treated plant grafted on untreated plant
4: Untreated plant grafted on treated plant

The treatments consisted of immersion of the third basal leaf in a 1000 p.p.m. aqueous solution of sodium 2, 4-dichlorophenoxyacetate three weeks prior to grafting (approximately 4 months before the pictures were taken).

The arrows point to the graft unions which are also marked by circular tags.

The modified leaves of the scion of Plant 4 are clearly visible just above the tag bearing the number.

Plant 1. A normal scion was grafted on a normal stock. No peculiarities were evident.

Plant 2. The scion as well as the stock was taken from a 2, 4-D treated plant. No modifications of leaves were noticed with the exception of those which had taken place before grafting. Evidently, the formative stimulus was absent after grafting took place.

Plant 3. A normal stock was grafted with a scion which originally was the apical portion of a treated plant. With the exception of those leaves which were modified before the scion was removed from the original plant no morphologically changed organs were recorded.

Plant 4. A treated stock was grafted with a scion which originally was the apical portion of a normal plant. The foliage of the scion exhibited morphological abnormalities which indicated that the stimulus had been transmitted through the graft union.

DISCUSSION

From the experimental results it would appear that greater quantities of the stimulus were stored in the stock portion, and from there could influence the scion whereas the treated scion contained a smaller amount of the causative agent. Hence, no downward transmission of it took place. However, in other experiments conducted (unpublished data) it became evident that a basipetal movement through graft unions may also occur. Zimmerman and Hitchcock (5) reported that the cut stumps of tomatoes treated with p-chlorophenoxyacetic acid produced many new shoots with modified leaves 30 days after treatment. They mentioned that it was not known whether the growing tips were still under the influence of the chemical applied to the stump or whether genetic changes, such as were induced by colchicine, could have occurred. The present findings indicate that no genetic changes were induced since the modified plants when grafted on normal stocks became normal. The influence extending through the graft union therefore appears to have been a direct transmission of a chemical effect.

The transport of 2, 4-D when applied to leaves has been shown by Mitchell and Brown (1) to be associated with the translocation of organic food reserves. However, as mentioned by Zimmerman and Hitchcock (6) only a few cases have been recorded in which the applied chemical was detected or identified by direct methods beyond the region of application. In fact, no positive evidence seems to exist

pertaining to the entry of 2, 4-D and its translocation as such. Nothing is known about the fate of the substance after its absorption and particularly during the subsequent period when morphological changes take place. The recent work by Wood *et al.* (4) indicates that radioactive 2-iodo-3-nitrobenzoic acid entered bean and barley plants in molecular form and was translocated as such. Under the assumption that 2, 4-D in the present experiment was likewise absorbed, translocated and retained as such for 3 weeks, the conclusion is permissible that it was 2, 4-D that moved through the graft union and caused the modifications of the leaves of the scion. However, until such an assumption can be proved conclusively, it is a matter of speculation whether the causative agent was 2, 4-D or a derivative or even a reaction product.

Since this work was merely undertaken in support of other studies on the relations of stock and scion, the information on the response to application of 2, 4-D must be considered as preliminary. It is being released, however, in order to convey the observations to those working with 2, 4-D and related substances.

SUMMARY

The formative stimulus which resulted from the application of sodium 2, 4-dichlorophenoxyacetate to tomato leaves was transmitted through graft unions from the stock to the scion several weeks after the plant used as stock was treated. The stimulus appears to be a directly transmitted substance, but its chemical nature is not further specified.

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JOURNAL ARTICLE ABSTRACTS

A Comparison of the Palatability of Hatchery-reared and Wild Brook Trout

BAEDER, HELEN A., TACK, P. T., AND HAZZARD, A. S.

Trans. Am. Fisheries Soc. 75: 181-185. 1945. [Journal Article 834 (n. s.) from the Michigan Agricultural Experiment Station]

Objective organoleptic tests scoring for aroma, flavor, texture, and moisture, were made for eight samples of wild brook trout *(Salvelinus fontinalis)* from two streams and for seven samples of hatchery-reared brook trout from two rearing stations. Samples were obtained during May, June, July and August, were cooked separately by the same method, and identified by the judges by code number.

Average scores of six judges showed all samples acceptable, but values for wild fish from both streams were significantly higher than for hatchery-reared trout. The color of the flesh and the overall appearance of the wild trout were also more attractive.

The possibility of improving the eating quality of hatchery trout through better nutrition was suggested.

Preparation of Crude Plant Extracts and Their Assay for Presence of Antibacterial Substances

LUCAS, E. H., PEARSON, KATHRYN, LEWIS, R. W., AND VINCENT, BETTY

Food Research. 13 (1): 82-88. 1948. [Journal Article 858 (n. s.) from the Michigan Agricultural Experiment Station]

A method of testing crude plant extracts for the presence of antibacterial substances is described. It consists of a modification of earlier methods used for the determination of antibiotics and adapts them to the purpose discussed. Instead of cups which were used in the Oxford test and its modifications filter paper disks are the carriers of the substances to be tested on an agar medium.

A stable standard of vegetable origin, dehydrated garlic, is introduced in this technique. In the evaluation of the plant materials tested the comparative potency is expressed in terms of garlic units. A number of tables and diagrams supports the evaluation presented.

Characteristics of Michigan's Fringe Population

BEEGLE, J. A.

Rural Sociology. 12 (3): 254-263. 1948. [Journal Article 865 (n. s.) from the Michigan Agricultural Experiment Station]

The age, sex, race and nativity composition as well as the fertility of "fringe" residents in Michigan were studied. Ten major areas around large cities form the focus of attention. Demographic data were secured for the urban center, the fringe (townships having 50 percent or more non-urban, non-village, and non-farm population) and adjacent rural-farm population. Proportions of foreign-born and Negroes in the fringe areas were found to be low. The sex ratio was high, although slightly lower than the adjacent farm population. Proportions of persons under 21 were high, while proportions of persons aged 65 and over were low. Birth rates in these areas were found to be extraordinarily high.

The Influence of Agitating the Freshening Water on the Desalting of Pickles

FABIAN, F. W., AND JACOBS, P. D.

Fruit Products Jour. 26 (8): 230-232, 253. 1947. [Journal Article 867 (n. s) from the Michigan Agricultural Experiment Station]

A study was made of the influence of agitation by compressed air on the rate of withdrawal of salt from pickles during the freshening process as compared with non-agitation. The pickles used were vat-run, ranging in sizes from 800 to 1,200 inclusive, and also No. 2 machine-graded pickles which included sizes from 4,500 to 8,000 inclusive. The pickles in the tanks were heated by a steam siphon and the water agitated by perforated galvanized iron pipes attached to compressed air. Two freshening waters were used in both sizes of pickles. The first freshening water of the vat run, sizes 800 to 1,200, showed that the salt was withdrawn faster from the pickles in the agitated than in the non-agitated tanks but at the end of 8 hours the salt remaining in the pickles was, however, found to be 1 percent less in the non-agitated than in the agitated tanks. After the second freshening, which consisted of allowing the pickles to stand in water overnight, the salt content was 1 percent less in the non-agitated than in the agitated tanks. The same results were obtained from the two freshening waters of the No. 2 vat machine graded pickles sizes 4,500 to 8,000. These results show that when the water is heated by means of a steam siphon there is no significant difference on the rate of withdrawal of salt from pickles when the covering water is agitated with compressed air. However, the agitation of the water does help to remove any dirt adhering to them.

The Lixate Method of Salting Cucumbers

FABIAN, F. W., AND BLUM, H. B.

Fruit Products Jour. 27 (4): 103-106. 1947. [Journal Article 912 (n. s.) from the Michigan Agricultural Experiment Station]

The Lixate method of salting pickles is a mechanized version of the brine method. The principal difference is that in the Lixate method the salt can be transported in pipes easily and quickly from one part of the salting station or factory to another. The process which involves the use of the Lixator combines a method of dissolving rock salt without agitation and a method of self filtration. One experiment which was done consisted of a combination of dry salting with rock salt and the Lixate method. In another experiment the Lixate method alone was employed. So far as the bacteriological and chemical data are concerned there was no significant difference between the two methods. The Lixate method involved less labor since there was no salt to be handled but just valves to be manipulated. The brine of a tank of pickles may be increased to the desired strength by withdrawing a small amount of brine from the tank and replacing it with saturated brine. This operation temporarily decreased the percentage of acid and the bacterial count. The withdrawal of small amounts of brine, about 4 percent, apparently had no effect on the curing of the cucumbers since both the acid and bacterial counts quickly regained what had been lost by withdrawing this small amount of brine from the tank.

The Potentiating Action of Sulfonamides on the Brucella Antibody Complement System

HUDDLESON, I. F.

Am. Jour. of Vet. Res. 9 (52): 277-285. 1948. [Journal Article 917 (n. s.) from the Michigan Agricultural Experiment Station]

Experimental data are presented in the foregoing experiments which show that certain of the sulfonamides form a highly active bactericidal complex with the specific anti-body complement system. This complex will prevent the growth of and kill *Brucella abortus, suis* and *melitensis in vitro* and *in vivo.*

It has been shown that the effectiveness of this complex in killing bacteria in a test tube or in a body of an infected animal was governed by the number of inactive complement-binding antibody molecules present in blood serum.

A procedure has been developed which either counteracts the action of inactive antibody molecules or possibly converts them into active ones.

Field Applications to Control Spittle Bugs in Michigan

PEDERSON, C. E., AND SHERMAN, FRANKLIN III

Jour. Econ. Ent. 41 (4): 659-661. 1948. [Journal Article 928 (n. s.) from the Michigan Agricultural Experiment Station]

A number of materials were tested in 1947 on strawberries, alfalfa and clover against spittle bug nymphs. The results indicate:

1. On strawberries, benzene hexachloride gave nearly perfect control, and there was no evidence of tainting when applications were made at least a week prior to harvest. Rotenone and nicotine sulfate also gave good control. DDT, hexaethyl tetraphosphate, and the DDT with fixed nicotine failed to provide satisfactory control.

2. On alfalfa and mammoth clover, benzene hexachloride gave very good control. The treated alfalfa showed a 14- to 18- percent increase in hay yield when cut 4 weeks after spraying.

Effect of Particle Size of Vermiculite Media on the Rooting of Cuttings

O'ROURKE, F. L., AND MAXON, M. A.

Proc. Amer. Soc. Hort. Sci. 51: 654-656. 1948. [Journal Article 937 (n. s) from the Michigan Agricultural Experiment Station]

Exfoliated vermiculite in five different grades, designated as S. F. No. 1, No. 2, No. 3, and No. 4 in descending order of particle size and one grade of common propagating sand were compared as rooting media for softwood cuttings of many ornamental deciduous shrubs under both normal and humidified greenhouse conditions. Results were tabulated according to index values arbitrarily assigned to individual cuttings based on the degree of rooting within a specific time. Cuttings of the majority of plant species responded best with the No. 2 grade, closely followed by the No. 3 grade, although a few species rooted well in the coarser grades and several others in the very fine grade. Nearly all species rooted better in any of the vermiculite grades than in sand.

Studies of the Protein Requirements of Women

OHLSON, M. A., BREWER, W. D., CEDERQUIST, D. C., JACKSON, L., BROWN, E. G., AND ROBERTS, H. P.

Jour. Am. Dietetic Assoc. 24 (9): 744-749. 1948. [Journal Article 966 (n. s.) from the Michigan Agricultural Experiment Station]

Healthy women of the North Central States eat food from a basic dietary pattern in which the intake of protein and calories is closely related. In order to provide 60 grams of protein per day or one gram per kilogram, careful selection of food is necessary as soon as calories are reduced below 1750 to 2000 per day. On a controlled diet, made up of foods characteristic of the group but eaten in prescribed amounts, 45 grams of protein per day per 60 kilogram woman were required for equilibrium in well nourished college-age individuals. When food was eaten *ad libitum,* 54 grams protein per day were needed. Aging women, consuming food *ad libitum*, required an average of 53 grams protein per 60 kilogram woman. None of these estimates allow for a factor of safety in utilization nor do they provide for the apparent capacity for protein retention in well nourished young women.

Evidence is available that protein intakes from 70 to 90 grams per day protect young women during certain periods of physiological strain. Few adult women of the North Central area eat more than 70 grams of protein per day unless more than 2000 calories are consumed.

The Identification of the Fatty Acids of the Fat from the North American Black Bear

SELL, H. M., TAYLOR, BETTY M., AND MILLER, E. J.

Jour. of the Amer. Oil Chemists' Soc. 25 (11): 416-417. 1948. [Journal Article 970 (n. s.) from the Michigan Agricultural Experiment Station]

A study has been made of the identification of the fatty acids of the fat from a North American black bear. The methyl esters of the fatty acids from the fat were prepared and fractionated through a Stedman Column. Myristic, palmitic, stearic, oleic, palmitoleic, and linoleic acids were identified by the melting points of the p-bromophenacyl ester of the saturated acids and the hydroxy and bromine addition compounds of the unsaturated acids.

Isolation, Cultivation and Identification of Brucella

NADOLSKI, E. B.

Michigan Bul. for Med. Technologists. 1 (1): 10. 1948. [Journal Article 989 (n. s.) from the Michigan Agricultural Experiment Station]

Brucella organisms are more readily isolated from human blood by employing a fortified Bacto-tryptose broth and incubating the culture under 10-percent CO_2 tension.

Preparation of the medium and the technique used in obtaining the proper gaseous tension are described.

Milk samples should be allowed to stand in a cold room for 24 hours to allow the cream to rise to the surface. The cream carries with it the majority of organ-

isms in the milk. 0.1 to 0.2 ml. samples of the cream are put on tryptose agar plates. The plates are incubated in 10-percent CO_2 at 37° C. for 4 days.

Isolated *Brucella* colonies are identified by the use of thionin and basic fuchsin dye plates and H_2S production. The latter is determined by the use of a strip of lead acetate paper placed inside a tube which contains a culture of *Brucella* streaked on a liver agar slant.

Very few workers have succeeded in isolating *Brucella* from the feces and urine of infected human beings.

QUARTERLY BULLETIN

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Agricultural Experiment Station

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CONTENTS

(Continued on Next Page)

THE QUARTERLY BULLETIN

The Quarterly Bulletin of the Michigan Agricultural Experiment Station is issued in February, May, August and November. It presents: 1) progress reports on long-term major research projects; 2) final reports on short-term projects and 3) short, timely articles of a popular nature that bring together information from various sources on subjects in which farmers are interested.

CONTENTS

(Continued from Outside Front Cover)

CORN BREAD OR PORK CHOPS?

By LARRY BOGER *and* ARTHUR MAUCH
DEPARTMENT OF AGRICULTURAL ECONOMICS

BULGING GRAIN BINS have long been a symbol of plenty. But bulging grain bins also have caused us a lot of trouble. In the years ahead this symbol should be changed. The health and well-being of the people should become the best sign of abundance. This would require a better diet for all of the people—more meat, milk and eggs. But we can't have this better diet with our present price support program for agriculture. Why are we supporting the price of some of our grains at levels that prevent their use as feed? Why don't we encourage the use of these grains as feed by removing price supports on them and supporting only livestock and livestock product prices? At the same time we would have the best answer to our grain surplus problem.

Those who represent us in Washington will be making decisions in the next few months on a program for agriculture that will be felt for years to come. They are vital decisions. Will agriculture get high support prices, with their inevitable twin, production or marketing control—or will it get flexible supports that attempt to keep production in line with consumer needs?

Hearings have already begun. Alignments have been made. Pushing for, or at least leaning toward, flexible price supports are the Farm Bureau, the Grange, and the National Council of Farmer Cooperatives. Strong for high support prices are the Farmers' Union and the local committeemen of the Production and Marketing Administration (Triple-A to most of us). They will be joined by those representing wheat, cotton, and tobacco since "balanced" production would mean considerable adjustment in their areas.

Each of these groups can see a "mandate" in the results of the November election. Before any decision is made let's stop and think over some of the real issues. We can then better decide whether we want flexible supports, rigid supports at a high level, or some other

ARTICLE 31-41

approach. But keep in mind that we should strive toward balanced production and consumption at a level satisfactory to consumers and at the same time provide an adequate income for farmers.

We all like to live in a land of plenty and prosperity. We like to have enough money to buy the things we need. On top of those things we really need, we want to have some other things. The horse and buggy used to take us places—now we want a car. We used to use oil lamps—now we want electricity. By the same token we can eat cereal products and survive, but we enjoy T-bone steaks, milk, eggs, and other livestock products. When all of these wants or needs are attained, they add up to a higher standard of living.

Soil conservation will be further emphasized with an increased production of livestock. Many of our crop acres will be seeded to grass. Livestock numbers will be increased to utilize the additional pasture. In turn, the manure from the livestock will increase the fertility of our cropland. It all adds up to further conservation of our resources and higher productivity.

PAST PROGRAMS

Most of us remember the type of agricultural programs we tried during the late 'twenties and through the 'thirties. The general idea of all the programs was to control the supply and strengthen prices. In spite of these efforts, production continued high and prices low. On top of this, we began to accumulate huge stocks of grain. These stocks

Fig. 1. High support prices for grain lead to grain surpluses, less livestock, and a less satisfying diet.

became known as surpluses, and at the outbreak of the war they amounted to almost one year's production.

It was good to have these large surpluses because of the war, but in normal times they are a real burden. But a support program for livestock alone would not entirely neglect this phase of security. First of all, we will have to provide for a minimum annual carry-over of grains in order to maintain feed supplies in years of poor crops. But in times of real emergency we could market more of our livestock and release still more grain for human food. We would have more meat to eat during the emergency, and at the same time, feed more people with the extra grain.

FEEDING SURPLUSES

For the years since 1930 an increase of about 2 percent in livestock numbers would have been more than enough to use our stocks of wheat. In fact, our country would have found herself with no stocks of wheat by 1935. If we would have used corn when we ran out of wheat, our corn stocks by 1943 would have been only about half what they were.

But how much more of these products would we have had to eat? If all of the increased production had been in hogs, we would have eaten about one more meal of pork each month. If all of it had been

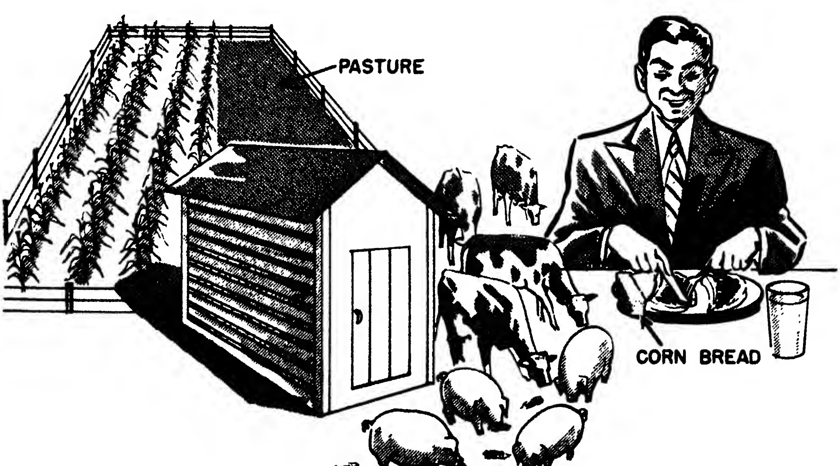

Fig. 2. Emphasis on livestock will eliminate grain surpluses, conserve the soil, and improve the diet.

in milk production, we would have consumed about one more quart a week. But of course we should not assume that all of the increase came in the same product. The following table illustrates how much more of all these products we would have eaten per person each year with a 2-percent increase in livestock numbers.

Milk	7 quarts
Beef	1 pound
Pork	1.2 pounds
Eggs	½ dozen
Chickens, Turkeys, and Lambs	1 pound

These figures are relatively small, and the expansion of livestock numbers probably could have taken place easily. Livestock numbers could have been expanded in the Great Plains, in parts of the South, the Pacific Northwest, and even in the Corn Belt where the greatest concentration of livestock now exists.

We can assume, then, that livestock production will be expanded if prices are favorable. This means that livestock will use more grain and reduce our worries about surpluses. Consumers and producers both will benefit. Consumers will have more livestock products to eat, and producers will be assured of a reasonable minimum price for livestock. The increased demand for livestock feed will be reflected in the prices paid for grain.

OTHER OBJECTIVES

Three other objectives of an agricultural program to reach these goals are:

1. A favorable relationship between feed and livestock prices should be maintained. The exact ratios should be determined on the basis of the desired level of production.

2. Food and fiber crops that cannot be marketed through livestock should be supported at levels low enough to encourage shifts to livestock production. However, the supports should be high enough to maintain production at a level necessary to meet our real needs.

3. Provision should be made for some carry-over of grain in years of high production. These stocks could be partially used in years when there is a temporary shortage of feed. Most of these stocks should be kept in the grain production areas and transferred directly to feed shortage areas to keep freight costs down.

PRESENT LAW

The changes made in the price support program to become effective in 1950 represent a big improvement over past programs. Emphasis has been shifted somewhat from grains to livestock and livestock products. But the flexible provisions of the new act may not be flexible enough to prevent surpluses and the inevitable production or marketing controls. On the other hand, if the provisions of the new act were made much more flexible, the prevention of a drastic drop in prices might be difficult. This might be true even though national income remained fairly stable. Something more is needed to assure the use of our excess grain production.

DANGERS OF FUTURE SURPLUSES

But—are there dangers of future surpluses? Prior to this last war, a billion bushel wheat crop was almost unheard of. In fact, the only time we had a billion bushels of wheat was in 1915. But we have produced a billion bushels or more each year since 1944. The year 1947 set a record with 1,365 million bushels—more than 50 percent higher than the average for the last 25 years. For the past six years we've had plenty of wheat for ourselves, as well as sizeable amounts left over to export. Wheat exports the last two years have been three and one-half times as much as the average for the last 25 years and have accounted for more than a third of our total production.

Even though the amount of corn we have produced in recent years has been fluctuating around the three-billion bushel level, the problem of surpluses is not as serious as it is with wheat. However, violent fluctuations in net exports of both commodities cause fluctuations in stocks. These, combined with the relatively even amount used domestically cause prices to change in our home market. Production always responds slowly to these changes. These fluctuations in exports are bad for our economy if we come to depend upon them as a steady and reliable outlet for our surpluses. Stocks create problems when they become large and depress market prices.

The war-torn nations of the world temporarily bailed us out of our surplus problem. But as European nations get back on their feet our exports of grain will be greatly reduced. This will mean rapid additions to stocks in the years ahead, particularly if our present levels of grain production are maintained. The best answer to this grain disposal problem lies in an expanded domestic livestock program.

This program will absorb more of our grain production domestically and reduce our dependency upon foreign outlets.

METHODS OF SUPPORT

In selecting a way to support livestock prices it will be necessary to establish equitable price relationships between livestock and livestock products as well as between livestock and grains. These will be necessary to maintain the incentives for greater livestock production. The program must also be associated with positive efforts to maintain full employment and to stabilize the levels of national income. A program for agriculture alone cannot work satisfactorily.

There are several alternatives to the method of supporting livestock prices. One would involve government purchase operations in established markets to bolster demand. The product could be disposed of through foreign or domestic relief programs. However, the present government holdings of dried eggs and powdered milk indicate some of the problems associated with this approach.

A second method would involve direct income payments to producers when market prices did not provide sufficient incentive to expand livestock production. This would be difficult to administer and might prove unpopular with producers.

The best method is a subsidized food consumption program. The first step involves expansion of the school lunch program. Another step in a food consumption program could be taken by setting up a food allotment plan. Nutritionists could determine that on a given date, a minimum adequate diet could contain a certain amount of livestock products. These might cost $4 and represent 10 percent of an average weekly income. The government could then allow any family to buy $4 worth of livestock product stamps for 10 percent of the family income. Obviously, anyone earning more than $40 a week would not find it advantageous to buy the stamps.

The advantages of a food consumption program are twofold:

1. It would move the products directly into consumption channels. No surpluses would pile up.

2. The health and usefulness of the low-income people as citizens would be greatly improved.

In keeping the prices of grains, such as corn and wheat, in line it might be necessary to set up a "Stocks Supervisory Board" that

would be required to maintain stocks at a minimum level. For example, let's say a combined total of 600 million bushels of corn and wheat. It would be the duty of the Board then to buy wheat and sell corn or vice versa to keep the prices of both products in line. It would be necessary to provide positive legal limits to the size of these stocks so as to prevent them from being built up and kept at levels so high as to interfere with the objectives of the livestock program.

Agricultural programs in the years ahead must be adaptable to the changing conditions of the American economy. Programs must take account of changes in production, consumption, and export. A support program for livestock is sound in principle since the dangers of future grain surpluses are great. In the years ahead, let's let the cow, the sow, the ewe, and the hen be our "ever-normal" granary. In this way the farmer can make a major contribution to the well-being of the American people.

YIELD AND QUALITY OF ASPARAGUS HARVESTED BY THE FIELD SNAPPING METHOD

By ROBERT L. CAROLUS
SECTION OF HORTICULTURE

THE DESIRABILITY of harvesting asparagus by snapping was suggested by Barrons in 1945 (1). He observed that harvesting by snapping in 1944 did not reduce the yield in 1945 and that this method of harvesting reduced the labor requirement by about 50 percent. It was also found that the labor cost of processing snapped asparagus was 55 percent less than that of processing cut asparagus. At the present time 25-35 percent of the Michigan asparagus grown for canning is harvested in this manner. Processors have been paying from 1.8 to 2.0 times as much for snapped as for cut spears. Where harvesting crews have been instructed and properly supervised in snapping, the product has been satisfactory and free of excessive fiber.

Reports from other states where green asparagus is grown, indicate that the practice is gaining in favor in many other areas. It has been suggested that temperature might influence the "break point" and that at high temperatures no definite break would occur between the very low and very high fiber regions of the stems. Studies in New Jersey (3), however, have shown that air temperatures do not affect the breaking point. In the same paper it was reported that to obtain a definite break at the junction of the high-low fiber region the spears should be at least 6 inches in height. Many growers have observed bleeding from the stumps when snapping is practiced and have questioned whether this loss of water and nutrients was not detrimental to the plant. In the New Jersey report, tests indicated that the loss of sap from the above-ground stumps was no higher than that from the underground cut stumps when the moisture in the additional length of the above-ground stump was considered.

In snapping, growers have reported that there is less tendency to snap above or below the normal "break point" when the spear is

ARTICLE 31-42

pushed away from the worker. When the spear is pulled toward the harvester, frequently it will snap so far down that a large fibrous portion is included. The fact that spears that are less than 6 inches in height do not snap satisfactorily at the "break point" encourages the field worker to allow them to stand an extra day in the bed. Under conditions of high temperatures, in excess of 75° F., this has resulted in a spear that may have increased in length by as much as 4 to 6 inches and one that in many instances has opened at the tip. Open tips in asparagus lower its quality and consequently result in its being off-graded by the canner. However, in Michigan where temperatures during the harvesting period generally average below 65° F. this problem is seldom encountered, as the rate of growth at temperatures less than 60° F. is seldom over 2 inches a day.

Ingenious equipment is being designed for use in harvesting asparagus by the snapping method. In one instance a series of from 5 to 9 low sleds fastened to a boom and attached to a tractor allow the workers to harvest the crop from a sitting position while they are being pulled down the middle of the row. Such a harvesting procedure would not be feasible if the workers were encumbered by cutting knives. Cutting from a sitting position would also be very hazardous to unemerged spears.

INFLUENCE OF THE SNAPPING METHOD ON YIELD

With the assistance of Mr. Donald Carpp and the Lawrence Packing company, a series of plots was laid out on a 3-year-old planting in Van Buren County in the spring of 1944. Fifteen plots, each one-hundredth acre in size, were used in comparing the productivity of the crop during a 4-year period in which snapping, above-ground cutting, and conventional below-ground cutting methods of harvesting were employed. During the first season it was found that it was impracticable to attempt to cut at the break point, so this series of plots was also snapped in subsequent years.

The results obtained in terms of pounds to the acre of edible asparagus during a 4-year period are shown in Table 1. The average percentage recovery of edible product reported by two local plants, 53.5 percent, was used in calculating the cannable portion of cut asparagus. The data were analyzed statistically by the analysis of variance method. In no year did either of the snapped treatments (No. 1 and 3) give a significantly lower yield of edible product than

TABLE 1—*Effect of harvesting method on yield of edible asparagus (Each value is the average of five plots)*

Method	1944	1945	1946	1947	Four-year average	Percent increase over cut
			in pounds to the acre			
1. Snapped.	670	1,088	2,205	1,570	1,383	+15.2
2. Cut*.	545	1,010	1,900	1,348	1,201	....
3. Snapped**.	502	927	1,780	1,580	1,197	−0.3
Average.	572	1,008	1,962	1,499	1,260	....
Relative S/C.	117	99.8	105	117	110	....

*Estimated 53.5% edible, based on factory averages.
**Edible portion cut above ground in 1944, snapped from 1945 through 1947.

Pounds required for significance:	5%	1%
Averages of 5.	130	175
Averages of 20.	65	88

that produced on plots harvested by cutting (No. 2). The yields varied significantly from year to year, owing to the fact that the planting was quite young in 1944, and as it matured the yields became larger. The decline in yield in 1947 was the result of unseasonably late frosts that year, which shortened the harvesting season.

The favorable influence of the snapping method of harvesting on yield is indicated by the fact that in the last two seasons, 1946 and 1947, the snapped plots (No. 1) produced 15.8 and 16.5 percent more edible product than the cut plots (No. 2). These differences are highly significant. In 1947, treatment No. 3 also produced highly significantly better than the cut plot.

It would appear from this data that the snapping practice is not detrimental to the planting but in time is significantly and practically beneficial. In snapping, the cut stumps are left in the field. In this experiment they amounted to from one-half to one ton per acre, which would be equivalent to from one-fourth to one-half a ton of a good legume green manure crop. In fields yielding several tons of snapped asparagus to the acre, about 3,500 pounds of stumps would remain. Analyses (2) indicate that this volume of material would contain 35 pounds of nitrogen and probably about 50 pounds of potash. Thus the organic matter itself and the nutrients it contained could help account for the improvement in yield on the plots on which snapping was practiced. Another reason for the increased relative production from snapped plots as contrasted to cut areas may be the fact that in snapping, unemerged spears are not subject to injury. All too fre-

quently when cutting is done by inexperienced labor, many unemerged spears are damaged or destroyed.

INFLUENCE OF SNAPPING ON THE PERCENTAGE OF EDIBLE PRODUCT

Many growers have felt that there is some loss in edible asparagus when the crop is harvested by snapping. It is also possible that field snapping may result in the inclusion of a portion that contains a high percentage of fiber. These possibilities were investigated in supervised harvesting studies in 1946 and 1948. Inexperienced help was instructed in the approved technique of snapping and cutting. One man was allowed to harvest 2 adjacent rows, one by snapping and the other by cutting. Five pairs of rows were harvested in 1946 and 6 in 1948. The stumps of all snapped spears were cut in the usual manner following snapping, and the cut spears were snapped in the conventional way after the asparagus had been cut.

The data in Table 2 indicate the percentage of edible product obtained by both methods of harvesting. From cut asparagus the percentage of edible product varied from 39 to 71 and from snapping the snapped portion of the total varied from 46 to 72. This rather wide variability in the edible portion is probably partly due to a difference in the snapping techniques of the individual workers. In 1946, during a rather cold period of weather resulting in slow growth, the edible product by snapping averaged 53 per cent, and by cutting,

TABLE 2—*Percentage of edible asparagus obtained by snapping and cutting procedures*

(*Percentages are based on weights of entire spears*)

Procedure*	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Average
A. 1946 Test—Harvested during cold weather, 45-55° F							
By cutting	39.1	49.4	62.5	55.6	49.1	....	51.1 ± 2.6
By snapping	48.4	50.8	57.2	60.6	49.6	....	53.2 ± 1.5
B. 1948 Test—Harvested during cool weather, 55-65°F.							
By cutting	42	63	50	71	47	54	54.5 ± 3.0
By snapping	63	72	69	48	62	46	60.0 ± 3.0

*Cut asparagus was snapped after cutting. The stubs (butts) of snapped asparagus were cut after snapping. In both cases the spears were cut from one-half to one inch below the soil surface.

51 per cent. In 1948 with slightly warmer temperatures resulting in more succulent growth, the edible product by snapping averaged 60 percent, and by cutting, 54 percent.

Owing to the variability in the results obtained by the individual workers, the differences between the average, in favor of snapping, were not statistically significant. However, an increase of ten percent in yield of edible product for the snapping procedure was found in 1948. This increase in yield for snapping may be due to the difference in type of leverage exerted when rigidly anchored spears are snapped with the use of only one hand, as contrasted to the type of leverage used when both hands are used in snapping cut asparagus. Perhaps some of the increase in yield for field snapping, reported in the 4-year test above, may be accounted for in a higher actual percentage of the possible weight being obtained through field snapping than was used in the calculation of the percentage in the factory snapped yields. Field snapping may result in a break that is nearer the fibrous region than can be obtained by factory snapping.

INFLUENCE OF SNAPPING ON THE FIBER CONTENT

To determine the influence of the type of harvesting on the percentage of fiber in the waste and in the normally canned portions, samples from the 1948 field tests were analyzed for their fiber contents. One-inch cuts from both the edible portion above and the waste portion below the "break point" of both snapped and cut spears were canned separately in No. 10 cans.

After 8 months' storage the fiber content of the various lots was determined from duplicate cans of each of the four lots. One-half of the drained contents of each can was thoroughly mixed and then mashed with a table fork. One-hundred gram aliquots were transferred to a Waring blender and violently agitated with 200 ml. of water for 5 minutes. The contents of the blenders were then washed through a 40-mesh-to-an-inch screen with about 1 liter of water, to remove all of the finer material. The stringy and fibrous material that remained was then removed from the screen, dried at 80° C. for 12 hours and weighed. The fiber contents expressed as percentages of the drained net weights of the various lots, as determined by this relatively simple comparative method, are found in Table 3.

TABLE 3—*Fiber content of the break region of cut and snapped asparagus (Percentage of the drained wet weight of the canned product)*

A. Field snapped

Portion analyzed, one inch	Interval between draining and blending (hours)	Blending time (minutes)	Sample 1	Sample 2	Average
1. Below break	0	5	.805	.815	.810
2. Above break	0	5	.012	.009	.010
3. Below break	18	5	.841	1.004	.922
4. Above break	18	5	.018	.020	.019
5. Above break	0	1	.061	.049	.055

B. Field cut

Portion analyzed, one inch	Interval between draining and blending (hours)	Blending time (minutes)	Sample 1	Sample 2	Average
1a. Below break	0	5	.575	.657	.616
2a. Above break	0	5	.004	.002	.003
3a. Below break	18	5	.701	.834	.767
4a. Above break	18	5	.016	.012	.014
5a. Above break	0	1	.030	.036	.030

The effect of the time interval between draining and blending and the influence of the blending time on the fiber contents is also included. In the field-snapped asparagus one-inch portions immediately below the break contained 0.81 percent fiber and those for the first inch above the break, 0.01 percent fiber. In post-harvest snapped asparagus one-inch portions below the break contained 0.616 percent fiber and those above the break 0.003 percent fiber.

These fiber percentages indicate that in field snapping more fiber is included in the cannable portion than in a factory-snapped product. However, in the snapped spears the one-inch portions just below the "break point" contained about 80 times as much fiber as the one-inch portions above the break. Noticeable fiber development in U. S. Grade A asparagus may not be present in more than 10 percent by count of the units (4). If the piece cannot be cut cleanly with a common table fork it is classified as having noticeable fiber development. Fifty pieces from each of the 4 lots were treated in this manner. All pieces from above the "break point" of either the snapped or cut spears were free from fiber on the basis of this test.

From these tests it would appear that asparagus that was either field-snapped or factory snapped, satisfactorily met the requirement for U. S. Grade A or U. S. Fancy on the basis of the fiber content. Field snapping, because it may result in as much as 10 percent more edible product than obtained by factory snapping, is not only satisfactory

from the viewpoint of a quality product but is also of economic benefit to the grower.

A study of the influence of the time interval between draining and blending and of blending time on the amount of fiber obtained (Table 3) indicates the necessity for using identical procedures with each lot for obtaining comparable results. Perhaps a shorter blending time which would result in a larger fiber residue would be entirely satisfactory.

DISCUSSION AND CONCLUSIONS

The practice of harvesting asparagus by snapping is economically sound from both the growers' and canners' viewpoints. When properly harvested, the snapped product is relatively free of objectionable fiber and capable of being harvested by the grower and handled by the canner at a 50-percent reduction in labor cost. In addition, the yielding ability of the planting is not impaired, but from the results obtained in the tests reported here, may be increased by from 10 to 15 percent. The increased productivity of the crop from snapping may be due either to better growth resulting from the practice or to a greater recovery of edible product, or to both of the above factors.

From the data given above it would seem that the practice should be unconditionally recommended to all growers and all canners. However, properly snapped asparagus containing only a very minimum of fiber requires constant supervision and inspection by both grower and canner. Only growers who are willing to instruct their harvesting labor adequately on the technique of snapping and to see that their instructions are followed should harvest the crop by this procedure.

To obtain an acceptable product the spear must be broken with the pressure applied by the thumb and fingers at a point not far below the top. If the spear is grasped too low down, the break may occur from one-half to more than one inch below the point where the fiber development occurs. Only 10 percent of the units in a can, as a maximum, may have a noticeable fiber development for a minimum grade A product. In canning, a spear is cut into three or four pieces. Therefore, if 30 percent of the spears are broken too low down, a grade A product becomes impossible. A product containing more than three to five tough pieces per can, although graded A on the basis of U. S. Standards, is so heavily discounted on the market today that the time will soon arrive when it cannot be profitably canned.

Only canners who are willing to make periodic checks on their growers to determine whether the product is free of excessive fiber should buy snapped asparagus. Snapped asparagus is more succulent, has a higher rate of respiration, and loses weight more rapidly than cut asparagus. Also, in a short time the cut ends dry and fiber development occurs in snapped spears. This makes it necessary that snapped asparagus be moved promptly from field to can. Snapped asparagus should be protected by damp bags when it is being moved from field to factory and never exposed to drying winds. To insure a quality product, snapped spears should be canned within 8 hours of harvest.

CAUTION

Asparagus is, comparatively speaking, a luxury item. Quality is imperative in maintaining consumer acceptance of this type of food product. The canner cannot maintain a demand for low-grade asparagus at a profitable price. A low-grade product marketed by one canner helps to reduce the demand for all asparagus. Canners would be well advised to reach an agreement for maintaining high uniform standards for snapped asparagus.

As the canner is the grower's market for the product, in the end, it is up to the individual grower to be sure that his product is up to a high standard and that all growers cooperate in this respect to insure a continued demand for the product. The snapping procedure of harvesting asparagus, although sound economically, can be advised only if both growers and canners are willing to cooperate in insuring a high-quality product.

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FORECAST OF FUTURE PUBLIC SCHOOL ENROLLMENTS, BY GRADES, IN MICHIGAN

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THE ENROLLMENT in the public schools of Michigan can be expected to rise annually, and by substantial additions, for another 8 years. An enrollment of 1,210,000 can be expected in 1955-56. If this prediction proves correct, there will be 212,000 more pupils than were enrolled in the public schools of Michigan last year.

Increasingly large enrollments have been experienced annually since 1944. The rising tide of school enrollees during the past four years is attributed largely to the increased number of births during the immediate pre-war years. In fact, with a few exceptions, births have been increasing annually since the depth of the depression in 1933. The peak year was reached in 1947; a total of 160,275 were born that year. These children will be largely responsible for an all-time record enrollment in kindergarten in 1952-53. During the twelve years following this date, that group will be advancing to successive peak enrollments throughout the various grades to a record-breaking high school graduating class in 1965.

The rising tide of school enrollments is creating needs for additional school buildings, school equipment, and teachers. These increased enrollments also point to the desirability of studying our hundred-year-old school district organizational set-up with a view of reducing educational inequalities.

BASIS OF FORECAST

In Michigan, the ratio of the number of children enrolled in kindergarten to those born five years earlier provides a means of forecasting enrollment in kindergarten from vital statistics data. Likewise, the ratio of the number enrolled in the first grade in a given year to those enrolled in kindergarten the preceding year can be used as a basis

ARTICLE 31-43

of forecasting enrollment in the first grade. It is the relatively constant ratio between the number of children in a given grade to the enrollment in the next grade the following year that serves as the basis for the forecasts presented in this article. The ratios are not necessarily the same from grade to grade.

Table 1 shows the enrollment for each grade in the public schools of Michigan for the year 1946-47 and for the year 1947-48 and also the percentage that the enrollment in each grade in 1947-48 was of the enrollment in the preceding grade the previous year. For example, the enrollment of 75,499 in the fifth grade in 1947-48 is 97.59 percent of the enrollment of 77,363 in the fourth grade the previous year. If this percentage is fairly constant from year to year—or if a rather definite trend of percentage increase or decrease is indicated over a period of years—it may be used with some feeling of confidence as a basis of making school enrollment estimates in the fifth grade for a period of years in the future.

TABLE 1—*Enrollment by grades in the public schools of Michigan in 1946-47 and in 1947-48*

	1946-47	1947-48	Percent that 1947-48 enrollment is of preceding grade in 1946-47
K	92,043	105,082	
1	93,544	99,033	107.59
2	84,159	85,907	91.84
3	82,749	82,321	97.82
4	77,363	80,982	97.87
5	73,895	75,499	97.59
6	71,554	72,624	98.28
7	68,735	71,033	99.27
8	65,284	65,655	95.53
9	64,079	63,580	97.39
10	59,292	56,974	88.91
11	51,769	50,662	85.44
12	45,882	46,637	90.09
Other	42,011	42,099	91.75

It will be noted that in all but one instance the enrollment in each grade was less in 1947-48 than that in the preceding grade the previous year. The carry-over to the next grade seems to be lowest, 85.44 percent, from the tenth to the eleventh grade, and highest, 99.27 percent—excluding kindergarten to the first grade—from the sixth to the seventh grade. Some children enroll in the first grade without a prior enrollment in kindergarten. This fact explains the relatively high per-

centage relationship, 107.59, between the first grade and kindergarten. As a rule, the pupils who are classed as "other" pursued post-graduate courses in the larger school systems, and any forecast as to their numbers during the coming years is subject to a relatively wide margin of error.

ENROLLMENT IN KINDERGARTEN TO BIRTHS FIVE YEARS PREVIOUS

There were enrolled in the public schools of Michigan during the school year 1947-48 a total of 105,082 children. This figure is 84.7 percent of the number of babies born about 5½ years earlier, or in 1942, when the number of births totaled 124,068. These figures and corresponding data for nine previous years are presented in Table 2. Estimates of future enrollments in kindergarten, based on number of births and estimated births, are also presented in this table.

The ratio of enrollments in kindergarten from 1938-39 to 1947-48 to births 5½ years previously rose somewhat irregularly during the preceding 10 years. The average percent during the latter half of the decade was 85.3 as compared with 83.0 during the first half of the decade. For purpose of forecasting future enrollments it is assumed that for a period of 6 years enrollments in the kindergarten of the public schools will be essentially constant at 85.0 percent of the number of births 5½ years prior, and essentially constant at 86.0 percent after that. For example, 85.0 percent of 125,441 births that occurred in Michigan in 1943 should result in an estimated enrollment in kindergarten of 106,630 in 1948-49. And 86.0 percent of an estimated number of 137,000 births in 1949 should produce an approximate enrollment of 117,820 in kindergarten in 1954-55.

The estimated enrollments in kindergarten for the next 5 years, as presented in Table 2, may be accepted with considerable reliance as it is based on official reports of recorded births. The estimated enrollments in kindergarten for 1954-55 and for subsequent years may be subject to considerable error because they are based on estimated births for 1949 through 1953.

It is reasonable to assume that births will continue to decline. This assumption is warranted, in part, on the downward trend in marriages the last two years. The United States Public Health Service reports, that for the nation as a whole, the decline in marriages in 1948 from 1946, "the only year in which there were more than two million mar-

TABLE 2—*Number of births in Michigan 1933-1942 compared to enrollments in kindergarten of public schools five and one-half years later; and number of births 1943-1948 and estimated births 1949-1953 in relation to forecasts of future enrollments in kindergarten*

Year	Number of births*	Enrollment in kindergarten†	Percent kindergarten enrollment is of births
1933	80,482	66,271 (1938-39)	82.3
1934	83,994	69,811 (1939-40)	83.1
1935	87,403	72,427 (1940-41)	82.9
1936	88,457	74,035 (1941-42)	83.7
1937	91,566	76,011 (1942-43)	83.0
1938	96,962	81,915 (1943-44)	84.5
1939	94,432	80,960 (1944-45)	85.7
1940	99,106	85,511 (1945-46)	86.3
1941	107,498	92,043 (1946-47)	85.6
1942	124,068	105,082 (1947-48)	84.7
1943	125,441	106,630# (1948-49)	85.0#
1944	113,586	96,890# (1949-50)	85.0#
1945	111,557	95,490# (1950-51)	85.0#
1946	138,572	119,030# (1951-52)	85.0#
1947	160,275	136,230# (1952-53)	85.0#
1948	153,748‡	130,686# (1953-54)	85.0#
1949	137,000#	117,820# (1954-55)	86.0#
1950	120,000#	103,200# (1955-56)	86.0#
1951	102,000#	87,720# (1956-57)	86.0#
1952	95,000#	81,700# (1957-58)	86.0#
1953	90,000#	77,400# (1958-59)	86.0#

*Michigan Department of Health, Bureau of Records and Statistics.
†Michigan Department of Public Instruction.
‡Provisional.
#Estimates by the author.

riages was about one-fifth, or close to one-half million marriages" and that "the 1948 figure was about one-twelfth below the revised total of 1,991,878 marriages in 1947."[1] There is usually a high correlation between marriage rate and the birth rate and since continued decline in marriages seems probable one may reasonably expect further declines in the birth rate. The forecasts of enrollment in kindergarten in 1954-55 and subsequent years need revisions, as official reports of births reveal the arrival of either more or fewer babies than the number predicted in Table 2. Any revisions of forecasts as to future enrollments in kindergarten may require some adjustment upwards or downwards of forecasted enrollments in the grades in subsequent years.

ASSUMPTIONS UNDERLYING ESTIMATED ENROLLMENTS IN GRADES

A study of the enrollment in a given grade in comparison with the enrollment in the preceding grade the previous year, and the constancy, variability and trend of this relationship over a period of years

[1]U. S. Public Health Service, advance release, April 4, 1949.

may serve as a basis of projecting future estimated enrollments. Table 3 contains the figures on which past tendencies and trends may reflect future enrollments by grades.

TABLE 3—*Percent that enrollment in each grade in the public schools of Michigan was of the enrollment in the preceding grade the previous year: 1937-38 to 1947-48*

Grades	1937-38 to 1938-39	1938-39 to 1939-40	1939-40 to 1940-41	1940-41 to 1941-42	1941-42 to 1942-43	1942-43 to 1943-44	1943-44 to 1944-45	1944-45 to 1945-46	1945-46 to 1946-47	1946-47 to 1947-48	10-year average
K to 1st......	119.42	117.64	114.09	114.32	114.40	116.20	113.51	112.95	109.39	107.59	113.95
1st to 2nd....	91.44	92.53	93.02	93.12	93.32	93.42	91.91	91.16	92.04	91.84	92.38
2nd to 3rd....	97.59	98.16	98.25	98.37	98.02	98.92	98.20	97.36	97.63	97.82	98.03
3rd to 4th....	98.69	98.59	99.49	99.27	98.97	99.57	98.14	97.41	97.87	97.87	98.59
4th to 5th....	98.53	99.07	99.06	98.91	98.39	99.87	97.84	97.08	97.64	97.59	94.40
5th to 6th....	98.13	98.63	98.62	98.18	103.16	99.66	97.67	97.39	98.25	98.28	98.80
6th to 7th...	99.54	99.46	99.88	99.56	99.05	95.19	98.85	99.50	99.64	99.27	98.99
7th to 8th....	97.34	97.44	97.00	96.07	94.32	96.75	95.42	94.99	95.27	95.53	96.01
8th to 9th....	95.82	96.00	95.48	93.95	93.36	93.53	94.72	95.06	95.50	97.39	95.08
9th to 10th ..	91.70	91.03	89.22	86.94	84.10	83.76	87.69	88.83	89.27	88.91	88.14
10th to 11th..	87.78	87.65	84.59	82.41	76.09	80.06	82.32	85.00	85.40	85.44	83.67
11th to 12th..	94.32	92.35	88.47	86.52	82.09	81.80	84.06	88.79	92.13	90.09	88.06
12th to other .	74.80	84.36	72.11	147.31	65.93	67.90	84.18	85.28	100.66	91.75	87.43

It will be noted from Table 3 that the percentage of enrollment in the first grade averaged 113.95 percent of kindergarten enrollment during the 10 year period, 1937-38 to 1947-48. The highest percentage was 119.42 at the beginning of this decade and the lowest was 107.59 percent at the end of the decade. The drop went into reverse during three of the ten years mentioned, but the average drop was 1.18 percentage points for the whole decade. It is possible though not probable that this trend of the past 10 years will continue. It is here assumed that the enrollment in grade one to kindergarten enrollment the previous year will be increasingly less than 1.18 until 1954-55 and remain relatively constant at 98.6 after this date.

The assumptions underlying forecasts of future enrollments in the other grades are as follows: that the ratio of the enrollment in the

2nd grade to the enrollment in the 1st grade will be essentially constant, namely 92.0 percent
3rd grade to the enrollment in the 2nd grade will be essentially constant, namely 98.0 percent
4th grade to the enrollment in the 3rd grade will be essentially constant, namely 97.8 percent
5th grade to the enrollment in the 4th grade will be essentially constant, namely 97.5 percent
6th grade to the enrollment in the 5th grade will be essentially constant, namely 98.2 percent
7th grade to the enrollment in the 6th grade will be essentially constant, namely 99.3 percent
8th grade to the enrollment in the 7th grade will be essentially constant, namely 95.5 percent
9th grade to the enrollment in the 8th grade will be essentially constant, namely 97.5 percent
10th grade to the enrollment in the 9th grade will be essentially constant, namely 89.0 percent
11th grade to the enrollment in the 10th grade will be essentially constant, namely 86.0 percent
12th grade to the enrollment in the 11th grade will be essentially constant, namely 89.0 percent
Other grade to the enrollment in the 12th grade will be essentially constant, namely 90.0 percent

Obviously, the enrollment in any given grade to the enrollment in the preceding grade the previous year will not be constant, as assumed,

but may probably be as irregular during the next 11 years as it was during the past 10 years. However, the nature and extent of future probable irregularities are not apparent and it is reasonable to assume it to be constant for the purpose of forecasting future school enrollments.

The probable future enrollment in the class labeled "others" is most difficult to predict. It can be affected tremendously by legislation. For example, enactment of legislation which creates community colleges would tend to increase the enrollment in this group.

ESTIMATED FUTURE ENROLLMENT

The figures in Table 4 indicate the estimated number of pupils who may be expected to be enrolled in the public schools of Michigan, by grades, during each of the next 11 years. Expected percentage changes since last year are also presented. The forecasts are based on the formulae or assumptions which have been discussed on the preceding pages.

It will be noted that the enrollment in kindergarten is expected to reach a peak figure of 136,230 in 1952-53, or 29.6 percent higher than last year's enrollment. Enrollment in the first grade, if these estimates are correct, will reach 137,220 in 1953-54, which is 38.6 percent higher than was the enrollment in the first grade last year. This super-size first-grade enrollment will create a 12-year bulge in school enrollment and when its pupils reach the sixth grade in 1958-59, the enrollment in the sixth grade may be 59.5 percent larger than last year's sixth grade class.

The peak enrollment in the elementary grades is expected about 1954-55, with a total of 924,000 pupils, which will be 25.3 percent more than last year's enrollment. It is estimated that there will be 186,000 more pupils enrolled in the public elementary schools in 1954-55 than in 1947-48, which is the equivalent of 6,200 additional classrooms of 30 pupils each.

The peak enrollment in grades 9, 10, 11, and 12 during the next decade may be expected in 1958-59, when an estimated enrollment of 276,000 will be 26.8 percent larger than the enrollment of 217,853 last year.

These forecasts can be affected by many factors, especially by a radical change in the prevailing population growth within the state. Since 1940, the natural increase of population in the state has been

TABLE 4—*Forecast of future enrollment by grades in the public schools of Michigan*

Grade	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59
K	105,082	106,630	96,890	95,490	119,030	136,230	130,690	117,820	103,200	87,720	81,700	77,400
1	99,033	111,830	112,230	100,870	98,330	121,220	137,220	130,180	116,170	101,760	86,030	80,560
2	85,907	91,110	102,880	103,250	92,800	90,460	111,530	126,240	119,760	106,880	93,620	79,150
3	82,321	84,190	89,290	100,820	101,190	90,950	88,650	109,300	123,710	117,370	104,740	91,740
4	80,983	80,510	82,340	87,320	98,610	98,960	88,940	86,700	106,890	120,990	114,790	102,440
5	75,499	78,960	78,500	80,280	85,140	96,140	96,490	86,720	84,540	104,220	117,970	111,920
6	72,624	74,140	77,540	77,080	78,830	83,610	94,410	94,750	85,160	83,010	102,340	115,840
7	71,033	72,120	73,620	76,990	76,540	78,280	83,020	93,750	94,090	84,560	82,430	101,630
8	65,665	67,840	68,870	70,310	73,530	73,100	74,760	79,290	89,530	89,860	80,760	78,720
K-8	738,147	767,330	782,160	792,410	824,000	868,950	905,710	924,750	923,050	986,370	864,380	839,400
9	63,580	64,020	66,140	67,150	68,550	71,690	71,270	72,890	77,310	87,290	87,610	78,740
10	56,974	56,590	56,980	58,870	59,760	61,010	63,810	63,430	64,870	68,800	77,690	77,970
11	50,662	49,000	48,660	49,000	50,620	51,400	52,470	54,870	54,550	55,790	59,170	66,810
12	46,637	45,090	43,610	43,310	43,610	45,060	45,740	46,700	48,840	48,550	49,650	52,660
9-12	217,853	214,700	215,390	218,330	222,540	229,160	233,290	237,890	245,570	260,430	274,120	276,180
Other	42,099	41,970	40,580	39,250	38,980	39,250	40,550	41,170	42,030	43,950	43,700	44,690
Total	998,099	1,024,000	1,038,130	1,049,990	1,085,520	1,137,360	1,179,550	1,203,810	1,210,650	1,200,750	1,182,200	1,160,270
Percent change since 1947–48												
K	100.0	1.5	−7.8	−9.1	13.3	29.6	24.4	12.1	−1.8	−16.5	−22.7	−27.3
1	100.0	12.9	13.3	1.9	−0.7	22.4	38.6	31.5	17.3	2.8	−13.1	−18.7
2	100.0	6.1	19.8	20.2	8.0	5.3	29.8	46.9	39.4	24.4	9.0	−7.9
3	100.0	2.3	8.5	22.5	22 9	10.5	7.7	32.8	50.3	42.6	27.2	11.4
4	100.0	−0.6	1.7	7.8	21.8	22.2	9.8	7.1	32.0	49.4	41.7	26.5
5	100.0	4.6	4.0	6.3	12.8	27.3	27.8	14.9	12.0	38.0	56.3	48.2
6	100.0	2.1	6.8	6.1	8.5	15.1	30.0	30.5	17.3	14.3	40.9	59.5
7	100.0	1.5	3.6	8.4	7.8	10.2	16.9	32.0	32.5	19.0	16.0	43.1
8	100.0	3.3	4.9	7.1	12.0	11.3	13 9	20.7	36.3	36.8	23.0	19.9
K-8	100.0	4.0	6.0	7.3	11.6	17.7	22.7	25.3	25.0	21.4	17.1	13.7
9	100.0	0.7	4.0	5.6	7.8	12.8	12.1	14.6	21.6	37.3	37.8	23.8
10	100.0	−0.7	0	−3.3	4.9	7.1	12.0	11.3	13.9	20.8	36.4	36.9
11	100.0	−3.3	−4.0	−3.3	−0.1	1.5	3.6	8.3	7.7	10.1	16.8	31.9
12	100.0	−3.3	−6.5	−7.1	−6.5	−3.4	−1.9	0.1	4.7	4.1	6.5	12.9
9-12	100.0	−1.4	−1.1	−0.2	2.2	5.2	7.1	9.2	12.7	19.5	25.8	26.8
Other	100.0	−0.3	−3.6	−6.8	−7.4	−6.8	−3.7	−2.2	−0.2	4.4	3.8	6.2
Total	100.0	2.6	4.0	5.2	8.8	14.0	18.2	20.6	21.3	20.3	18.4	16.2

supplemented by substantial additions through migration from other states. It is estimated that the population of Michigan was 6,069,000 as of July 1, 1947, an increase of 812,894, or 15.5 percent over the population figure of 5,256,106 on April 1, 1940. Of this total increase in population, it is estimated that natural increase (excess of births over deaths) totaled 482,749, and that net migration to Michigan totaled 330,145. Thus natural increase contributed 59 percent to the growth of population of Michigan since 1940 and migration from other states and countries contributed 41 percent.[2] A severe economic recession may slacken the flow of migrants to Michigan and, consequently, affect these forecasts of school enrollments somewhat.

However, these population forecasts are likely to be affected more by changes within the state, than by changes in inter-state migration. This can be illustrated by a change in the school code several years ago and its apparent affect on secondary school enrollments the following year. A law which makes school attendance compulsory until the age of 16 years was enacted by the Michigan legislature in 1947 which materially affected a forecast of school enrollment in high school, especially in the tenth grade.

Table 5 presents the enrollment in the public schools of Michigan for the year 1947-48, by grades and also a forecast of expected enrollments, which was made about a year before the actual enrollments in

TABLE 5—*Forecast of school enrollment compared with actual enrollment: 1947-48*

Grade	Actual Enrollment	Estimated Enrollment*	Percent Difference
K	105,082	105,457	0.4
1	99,033	101,246	2.2
2	85,907	86,060	0.2
3	82,321	82,164	−0.2
4	80,983	80,977	.0
5	75,499	75,536	.0
6	72,624	72,602	.0
7	71,033	71,296	0.4
8	65,663	65,482	−0.3
K-8	738,147	740,820	0.4
9	63,580	62,346	−1.9
10	56,974	52,930	−7.1
11	50,662	50,635	0
12	46,637	47,695	2.3
9-12	217,853	213,606	−2.0
Others	42,099	38,000	−9.7
Total	998,099	992,430	0.6

*J. F. Thaden, "Effect of the Increased Birth Rate on School Enrollment and School Building Needs." Mich. Agri. Exp. Sta. Quart. 31 (Aug. 1948): 1-11.

[2]J. F. Thaden, "Population Changes in the Rural and Urban Areas of Michigan Since 1940." Mich. Agr. Exp. Sta. Quart. Bul., *31* (Nov. 1948): 233-249.

1947-48 became available. It will be noted that the forecasted enrollments differ from the actual enrollment by less than 1 percent for all grades except first, ninth, tenth, and twelfth. The forecasts made a year ago are based on formulae different from those used in the present forecast of future enrollments.

The forecasted enrollment for the tenth grade was underestimated by about 4,000 pupils, or 7.1 percent. Forthcoming legislation that will affect future school enrollments can not always be foreseen, or if so, the year that such legislation will be enacted.

SOME IMPLICATIONS

In general, the public seems unaware that school enrollments in most grades and during most years throughout the 1950's will inevitably be much greater than during the 1940's. Already thousands of students in elementary schools are attending half-day sessions and frequently in buildings that are ill-adapted for classrooms. Almost daily, news items inform us that propositions for additional school buildings are voted down. At present, many elementary schools are overcrowded and understaffed. Classes of more than 50 pupils are quite prevalent in rural as well as in urban areas of the state. More than 12,000 elementary-school children, not including those in kindergarten, are in school only part time because there are not enough classrooms for them to attend school full-time. These conditions will get increasingly worse for at least seven or eight more years unless real efforts are made to meet the increasing needs.

Creation of community school districts with flexible school attendance areas are possibilities as means of solving some perplexing present-day educational problems on a long-term basis. Administrative and school taxing units which are organized on the basis of natural, sociological communities have inherent potentialities for meeting emergencies, such as the present and immediate future school building and teacher crises; more so than more ancient, smaller, and relatively inflexible school organizational units. There is a need, a much greater need than existed heretofore, of citizens within their respective communities making thorough studies of their school district organization and formulating plans to meet inevitable educational needs of the immediate future.

THE AGRICULTURAL EXPERIMENT STATION, SEED CERTIFICATION, AND THE MICHIGAN FOUNDATION-SEED ASSOCIATION, INC.

By R. E. DECKER
SECTION OF FARM CROPS

THE FUNCTION of the Michigan Crop Improvement Association as a certifying agency for crop varieties, recommended for certification by the plant breeders in the Farm Crops Department, has become quite well established in the minds of Michigan farmers during the past three decades.

Recently there has been organized the Michigan Foundation-Seed Association, Inc. What position does it occupy in relation to the Michigan Crop Improvement Association and to the Michigan Experiment Station?

In answering this question the work of all agencies will be explained so that their relationship, one to the other, will be better understood.

PLANT BREEDING AS APPLIED TO FIELD CROPS

Before the late Prof. Frank Spragg joined the staff of the Michigan Agricultural Experiment Station in 1906 practically no work had been done at this station in the improvement of field crops through plant breeding methods. From that time, however, the development and testing of new varieties has been one of the important activities in the experimental work of the Farm Crops Department.

Professor Spragg worked with all field crops. His early work was with oats and he introduced varieties named Alexander, College Success, and College Wonder.

As new varieties were developed small amounts were sent out to farmers in different parts of the state to grow in the same field with the variety they had been growing. One of the requirements in obtaining some of the new seed was that the grower report on how the new variety had performed.

ARTICLE 31-44

It was not long until men interested in this work formed an organization known as the Michigan Experiment Association.

But testing and reporting of results of tests was not accomplishing all that was desired. Pure seed of the new varieties was not being produced in any quantity and, therefore, the majority of farmers were not benefited by the work that the plant breeders had done.

The plant breeders at the Experiment Station were doing their work, a few farmers were growing some of the improved varieties, many more farmers wanted seed, but there was no quantity of pure seed being produced for them.

Such was the situation in 1917 when the members of the Michigan Experiment Association and members of the Experiment Station staff decided that a different type of organization should be formed.

THE MICHIGAN CROP IMPROVEMENT ASSOCIATION

The new organization was named the Michigan Crop Improvement Association. It was incorporated under the non-profit laws of Michigan.

Membership in the new organization was open to any farmer in the state who wished to grow seed of varieties which the plant breeders had found superior and which had been recommended for increase. The grower would sow pure seed, and have the growing grain inspected just before harvest by inspectors trained by members of the Farm Crops Department staff. After threshing he would submit a bin sample of the grain for purity and germination tests. If his crop passed both the field and bin sample inspections it was certified as to varietal purity.

Michigan was one of the first states to organize a Crop Improvement Association. Today there are approximately 35 states with similar organizations. In most of these states the certifying organization works very closely with the agricultural experiment station and the extension service. Seed improvement work is one of the projects approved by the federal extension service. Pure seed of adapted varieties is essential if maximum yields and top quality are to be obtained from the crops we grow.

In many states, including Michigan, the secretary of the crop improvement association is an extension specialist on the college staff.

The way the association was organized in this state, the head of the Farm Crops Department and one of the plant breeders, represent the Agricultural Experiment Station on the association's Board of Directors.

Who determines when a variety is worthy of inspection and certification? In Michigan the plant breeders, who have tested a variety for at least 3 years in different sections of the state, decide whether the performance of the variety merits its being introduced for inspection and certification. Yield, quality, resistance to disease, commercial preference, are some of the factors considered in arriving at a decision.

Varieties considered are not limited to those developed by Michigan's own plant breeders. Each year new varieties of various crops are obtained from other states and tested at East Lansing and in the overstate trials. Wisconsin No. 38 barley, Yorkwin wheat, several corn hybrids, soybean varieties and most of the potato varieties now certified in Michigan were developed by other experiment stations. On the other hand, Spartan barley developed in Michigan is still popular in some midwestern states. Michelite beans are widely grown in New York state.

Briefly, the Michigan Crop Improvement Association is an organization of Michigan farmers who are interested in producing pure seed of those field crop varieties which possess outstanding characteristics. The plant breeders of the Agricultural Experiment Station decide whether a variety is worthy of inspection and certification by the Crop Improvement Association.

THE MICHIGAN FOUNDATION-SEED ASSOCIATION, INC.

As the interest in production of certified seed has increased there have been new problems for the Crop Improvement Association. The production of parent stock of corn hybrids requires that somebody, or some organization, take the responsibility of producing that parent stock. Whenever a new small grain has been approved for certification it is necessary that somebody grow enough seed so that a large quantity can be produced for release to certified seed growers.

The Michigan Crop Improvement Association assumed the responsibility of having parent stock of corn hybrids produced. The organization also located growers to make initial increases of seed of small-grain varieties.

In order to relieve the Crop Improvement Association of these assumed responsibilities the Michigan Foundation-Seed Association has been formed. This organization has been incorporated under the non-profit laws of Michigan.

The purposes of this new organization as set forth in its by-laws are:

> . . . to promote, encourage, foster, facilitate and assist in the development of the Agricultural industry in the state of Michigan in cooperation with the United States Department of Agriculture, Michigan State Department of Agriculture, Michigan State College, Michigan Crop Improvement Association, and any other governmental agency, and any parties or associations interested in promotion of the objects for which this corporation is formed through the selection, breeding, propagation, production and distribution of improved strains and varieties of agricultural and horticultural seeds and stocks for vegetative propagation, and to promote and foster in cooperation with the Michigan State College educational and research activities and programs in connection therewith; to make available to Michigan farmers improved strains and varieties of seeds and stocks for vegetative propagation and to receive and expend funds for these purposes.

Membership in this new organization shall be open, but limited, to the members of the Michigan Crop Improvement Association who have entered into and are parties to an agreement with this corporation for the production of certified seeds.

There are no members of the Agricultural Experiment Station staff on the Board of Directors of this new organization, although members of the staff may and have been asked to advise with the Directors. The Directors have employed a manager who is not on the College or Agricultural Experiment Station staff.

SUMMARY

Plant breeders on the Farm Crops staff will continue to develop and test new varieties of field crops and they will continue to test new varieties developed at other state agricultural experiment stations. After at least 3 years of trials any variety showing exceptional characteristics may be recommended for increase and certification in Michigan.

The parent stock will be released to the Michigan Foundation-Seed Association, Inc., for increase, such increase to be supplied to growers of certified seed.

The Michigan Crop Improvement Association will inspect field crops grown for certification and certify the seed from such crops if it meets the required standards.

FOUR YEARS OF SOW TESTING IN MICHIGAN

By H. F. MOXLEY and W. N. McMILLEN
SECTION OF ANIMAL HUSBANDRY

THE MICHIGAN Sow Testing Project was started in 1945 with the slogan, "More pork from fewer sows." Litters entered are ear-marked at birth. The farrowing date and record are verified within 7 days by an official witness. The pigs are weighed out at 56 days or as near that age as possible and the weights adjusted to the 56-day basis, using a conversion table. The witness may be the county agricultural agent. the vocational agriculture instructor, or someone appointed by them.

To encourage participation in the project the Michigan Swine Breeders' Association awards a medal to each contestant making certain achievements.

Medal awards are determined as follows:

1) *Litters from sows*—Gold—400 pounds or more
Silver—350 to 399 pounds
Bronze—300 to 349 pounds

2) *Litters from gilts*—Gold—350 pounds or more
Silver—300 to 349 pounds
Bronze—250 to 299 pounds

Each participant is eligible for only one medal, the one representing the highest litter weight from his herd. Sows and gilts raising litters weighing 250 pounds or more are listed in the project report each year.

RESULTS AND DISCUSSION

A summary of the data for the four years is arranged by litter weights in Table 1 and by litter size in Table 2. About 80 percent of the litters that were entered finished the project over the four years. Sixty-three percent of the sows and gilts finishing the project produced litters weighing 250 pounds or more. The data include records on

ARTICLE 31-45

1,198 litters and 10,114 pigs weaned. The average size litter weaned was 8.4 pigs and the average pig weight 33.2 pounds.

TABLE 1—*Comparisons of litter data arranged in grouping litter weights at 56 days: 1,198 litters — 10,114 pigs*

Weight of litter at 56 days, in pounds	Number of litters in group	Percent of litters in group	Average number pigs weaned	Average weight of pigs at 56 days, in pounds	Average litter weight in each group, in pounds
400 lbs. and over....	108	9.0	10.5	42.5	447.3
350 lbs. to 399 lbs....	142	11.9	9.7	38.2	369.5
300 lbs. to 349 lbs....	238	19.9	9.1	35.4	322.0
250 lbs. to 299 lbs....	259	21.6	8.6	32.0	274.1
200 lbs. to 249 lbs....	237	19.8	7.8	28.9	225.9
150 lbs. to 199 lbs....	139	11.6	7.0	25.5	179.1
149 lbs. or less......	75	6.2	5.0	23.2	115.8

Pigs weaned 8.4 Average weight 33.2 pounds.

TABLE 2—*Comparison of pig and litter weights due to size of litter 1945 to 1948 inc. 1,198 litters — 10,114 pigs*

Size of litter	Litters in group	Percent of litters in group	Average weight of pigs at 56 days, in pounds	Average litter weight at 56 days, in pounds
11 or more..................	143	11.9	33.0	375.3
10.........................	208	17.4	32.8	328.1
9..........................	258	21.6	33.8	304.0
8..........................	246	20.5	33.4	263.7
7..........................	176	14.7	33.1	231.4
6 or less..................	167	13.9	32.9	175.7

Pigs weaned 8.4. Average weight 33.2 pounds.

The data show that size of litter is of major importance in achieving high litter weight. There is little difference in average pig weight due to litter size in litters up to 11 pigs. There is a wide weight range within each litter size group. The high average pig weight has fallen in a different litter size group each of the four years the project has been conducted. Only two litters of eight pigs have attained 400 pounds or more.

Results of each of the four years are very similar. Each year the 10 high sows weaned as many pigs as the 20 low ones. The litters of the 10 highest producers weighed as much at 56 days as the litters from the 30 low sows.

The entries have been almost equally divided between sows and gilts. Mature sows have weaned 0.5 to one pig per litter more each year than did the gilts. The pigs from sows averaged 2 to 4 pounds

heavier than the pigs from gilt litters. Advantage of litter size and pig weight in favor of the sows over gilts is increasing since good sows are kept and the poor producers culled.

Some idea of the repeatability is gained from the fact 28.8 percent of the litters in the 1948 project were from sows that had made records or from gilts whose dams had been tested. Of the litters weighing 400 pounds or more, 43.2 percent were from tested dams. There is a strong tendency for sows producing heavy litters to repeat. There is a great variation in the production records of gilts from tested sows, even among litter mates. One farmer had a sow that weaned a 1948 spring litter that at 56 days weighed 534 pounds and also a fall litter from the same sow that weighed 502 pounds. As a gilt the preceding year, this sow weaned a litter that weighed 484 pounds. The dam of this sow won the 1946 project with a litter that weighed 579 pounds at 56 days of age.

The principal value in increasing productivity in swine so far has been by improved management through extension contacts with project cooperators. For example, one county that had only 9 litters weighing over 250 pounds in 1945 had 46 in 1948. On several farms the weaning weights increased as the cooperators found out how to improve their feeding and management practices.

Another value lies in the increasing interest in production factors. Breeders and buyers are becoming more observing of the number of udder sections, femininity, litter size and other indications of production. There is a tendency for gilts and boars of acceptable type from production litters to outsell those from small litters or those with poor underlines.

The almost constant contact between the extension staff and the county leaders in sow testing has been a big factor in the establishment of seven county and district swine breeders associations representing 12 counties.

WHAT ALFALFA VARIETY FOR MICHIGAN?

By S. T. DEXTER
SECTION OF FARM CROPS

NEW ALFALFA varieties of some promise are continually being brought out by plant breeders in various parts of the country. As seed becomes available in sufficient amounts, these varieties are thoroughly tested in fields at the agricultural experiment stations, where they can be examined for disease and insect resistance, ease of seeding, winter hardiness, yields, etc. If the varieties seem useful, seed supplies are gradually increased, and eventually become available to farmers in general. Three such varieties, Ladak, Ranger, and Buffalo, have recently been recommended to combat bacterial wilt disease in alfalfa.

Ladak, the oldest variety, is only moderately resistant to bacterial wilt, but is winter hardy and survives reasonably well where wilt is severe. The variety has several objectionable features. First of all, it is highly variable, and seed from different regions may give fields widely different in growth behavior. In general, it is slow to start in the spring, is slow to start up after cutting, and has a short growth in the fall or late summer when the days begin to shorten. It is a little later to mature than our common Michigan Grimm and variegated, and can be cut at the end of the haying season. True Ladak tends to give but one cutting when handled in that way, and this cutting is likely to yield more than the first cuttings of ordinary alfalfa. Over a period of years it has yielded about as well each year as any other variety. Farmers have objected to the small growth during the summer and fall. It is less green than Hardigan, and flowers less profusely. For the northern part of Michigan where one cutting is common, it seems a good variety.

Ranger, a newer variety, is a Turkestan alfalfa, highly resistant to bacterial wilt, but somewhat less cold resistant or winter hardy than our best Michigan Grimm or Hardigan. Under field conditions, it

ARTICLE 31-46

rarely outlasts Grimm to a practical extent, since by the time the Grimm is killed by wilt, the Ranger is likely to be thinned by winter injury or diseases other than wilt to such a degree that the field is not worth leaving for hay. Under very severe conditions of wilt, it would probably be superior to Grimm. It has given yields around 90 to 95 percent as much as Grimm or Hardigan, over a testing period of about 10 years. It is a little earlier to start in the spring than our standard varieties. It tends to be yellowish, rather than bluish-green, with decidedly less bloom than Grimm. Leaf diseases cause some trouble.

Buffalo is a selection from Kansas Common strains, but possesses high resistance to bacterial wilt. It seems well adapted to regions as far north as central Ohio, Indiana and Illinois, and might be satisfactory in regions in Michigan where winter-killing is not much of a problem. It tends to start growth rather early in the spring, and at the Lake City Experiment Station, spring frosts have frequently frozen it back severely. This greatly weakens the plants and cuts down the yield of hay. In some years, the plants are decidedly yellowish, and by no means as attractive in appearance as the standard varieties.

Over a period of about 10 years, one or more of these three varieties has been tested in comparison with Grimm or Hardigan in large field plots. Brief descriptions of the experiments and tables of the yields of hay are given below.

COMPARISON OF LADAK AND HARDIGAN

To compare Ladak and Hardigan alfalfas, fields were planted in alternate strips of these varieties, both alone and in mixture with brome grass, timothy, orchard grass, and red clover. Since corresponding plots occurred with both varieties, hay yields are reported without regard to the particular mixture.

In 1936 a field was seeded at East Lansing, so that three different systems of cutting might be studied with the two varieties. Table 1 shows the three systems of cutting and the yields of hay obtained. After two years of cutting, these plots were plowed up, since a very heavy loss of stand occurred in the summer of 1938, owing to bacterial wilt in both varieties.

TABLE 1—*Yield of oven-dry hay per acre from plots of Ladak and of Hardigan in pounds per acre**

CUTTING TREATMENTS

Date cut	(Bud) Fl. Bl. and Nov.		(Bud) and Fl. Bl.		Fl. Bl. and Fl. Bl.	
	Lakak	Hardigan	Ladak	Hardigan	Ladak	Hardigan
Year 1937						
June 11	3327	3317	3715	3615		
July 6					4225	3995
August 13	2946	2755	2854	2829		
August 25					2505	2609
November 4	501	705				
Total 1937	6774	6777	6569	6444	6730	6604
Year 1938						
June 9	3295	3532	3198	3350		
June 30					4655	4541
July 30	1663	1571	1772	1681		
August 26					1182	1012
November 1	691	736				
Total 1938	5569	5839	4970	5031	5837	5553
Total 2 years	12343	12616	11549	11475	12567	12157

*Three systems of cutting management were practiced on field plots of Hardigan and Ladak in various mixtures with grass and clover. The oven-dry weights of hay per acre harvested on the dates shown are given in the table. Seeded in 1936, both varieties were destroyed by wilt in late summer of 1938.

The experiment was repeated on another field, with the results shown in Table 2.

TABLE 2—*Yield of oven-dry hay per acre from plots of Ladak and Hardigan in pounds per acre**

Date cut	(Bud) Fl. Bl. and Nov.		(Bud) and Fl. Bl.		Fl. Bl. and Fl. Bl.	
	Ladak	Hardigan	Ladak	Hardigan	Ladak	Hardigan
Year 1940						
June 17	4013	3974	3844	4027		
July 2					4530	4451
August 15	1910	2243	1906	2179		
September 4					1792	2094
November 4	532	800				
Total 1940	6465	7027	5750	6206	6322	6545
Year 1941						
June 11	3785	3767	4066	4098		
June 24					4389	4248
August 6	1407	1427	1415	1513		
November 3	216	299			1112	1332
Total 1941	5408	5493	5481	5601	5601	5580
Total 2 years	11873	12520	11231	11807	11823	12125

*As in Table 1, but seeded in 1939. Drowned out in winter 1941. Yields of oven-dry hay harvested per acre are shown.

It is apparent that there is little difference in the yield in these varieties. Although the Ladak was definitely less green than the Hardigan, and had fewer blossoms, it did not show the expected slow recovery in second growth, nor any appreciable superiority in wilt resistance. Its fall growth was less than in Hardigan. This Ladak was "certified" seed. Other lots of Ladak seed have shown the characteristic slow recovery in some cases, but the Ladak seed lots used have been highly variable. One is led to suspect that in many cases even certified Ladak has become mixed and is not fully true to the original characteristics of the variety. In the later years of the experiments, after this difficulty was recognized, particular effort was made to obtain true Ladak seed.

To compare the varieties farther north, a field was put in at Lake City Experiment Station in 1937. Part of the field was very heavily fertilized. The yields from early and from late cutting are shown in Table 3.

TABLE 3—*Yields of oven-dry hay at Lake City in pounds per acre (Seeded 1937)**

June 17 (bud)	Ladak	Hardigan	July 1	Ladak	Hardigan
		1938			
Ordinary fertilizer	2874	2862		3379	2916
Heavy fertilizer	3272	3207		3755	3384
		1939			
June 20					
Ordinary fertilizer	3114	2412			
Heavy fertilizer	3744	2988			

*Seeded in 1937, hay yields were taken in 1938 and 1939, after which the field was pastured. Oven-dry yields of hay for one cutting are shown. Each figure is the average yield from six plots.

After two years of cutting, the field was used as pasture, the varieties seeming about the same. Although these figures are not particularly extensive, they indicate that the Ladak variety may be superior in a region where but one cutting of alfalfa is usual. Later results (Table 7) seem to confirm this view.

COMPARISONS OF LADAK, HARDIGAN, AND RANGER

When Ranger seed became available, this variety was included in the alfalfa trials. The three varieties were seeded at East Lansing both

alone and in various proportions with timothy. In the first cutting part of each plot was cut early and part late. Table 4 shows the weights of hay taken per acre at each cutting.

TABLE 4—*Summary of the yields of dry matter of Hardigan vs. Ranger vs. Ladak in pure stands and in mixture with timothy**

Variety	Year 1942						Year 1943					
	First cutting taken early			First cutting taken late			First cutting taken early			First cutting taken late		
	1st	2nd	Total	1st	2nd	Total	1st	2nd	Total	1st	2nd	Total
Hardigan	3901	3361	7262	4452	3708	8160	3950	1306	5256	4286	1895	6181
Ranger	3721	2951	6672	4138	3237	7375	3846	1218	5064	4027	1772	5799
Ladak	4226	3521	7747	4906	3496	8402	4058	1054	5112	4147	1773	5920

*Hardigan, Ranger, and Ladak, seeded alone and in various mixtures with timothy. The yields of hay are shown under various methods of cutting management. The field was not worth leaving for hay in 1944 owing to winter-killing and drowning out. Each figure is the average of weights from 18 plots.

In Table 5, the results are summarized. Since cuttings were taken both late and early, and of mixtures with grass as well as of pure alfalfa, the figures represent as nearly as possible "alfalfa hay" as it might be planted and cut in this region.

TABLE 5—*A summary of Table 4, comparing three varieties under a wide range of conditions of cutting and in mixtures**

	1942 Grand Ave. 2 cut total	1943 Grand Ave. 2 cut total	Total yield in 2 cuts in 2 years	Yield November 1 cutting 1942	Grand total	As percent
Hardigan	7710	5719	13429	535	13964	100
Ranger	7024	5432	12456	357	12813	91.7
Ladak	8075	5660	13735	227	13962	100

*For each variety, the same mixtures, in equal numbers, with timothy were used. The cuttings were taken both early (i.e. near the start of haying season) and late (near the end of haying season). Thus, as nearly as possible, the figures represent "alfalfa hay" as it might be cut and planted in this region.

Since Ranger is a variety made up by mixing several strains, which then cross, making "hybrids", it was thought advisable to test some first-generation crosses against some later generations, in comparison with Grimm or Hardigan alfalfa. No differences were notable between the various Ranger generations. Table 6 shows the yearly yields of the Rangers as compared with Grimm alfalfa.

The seed of the new variety Buffalo became available in 1944 and was included in the plots on a field basis at both Lake City and East

TABLE 6—*Comparing Grimm alfalfa with several generations of Ranger, at East Lansing. Yield in oven-dry hay per acre*

Year	Cuttings	Grimm	Ave. of Ranger
1943	2	6274	5833
1944	2	4994	4598
1945	2	6058	5733
1946	1 weedy	2003	2325
Totals		19329	18489
		100%	94.4%

TABLE 7—*Hay yields of Ladak, Ranger and Buffalo alfalfas, in comparison. Grimm used as the standard, 100%*

Year	No. of cuttings	Variety				Remarks
		Grimm	Ladak	Ranger	Buffalo	
East Lansing						
1947	1	100	....	84.3	68.7	Seed 1946
1948	1	100	....	96.3	84.5	Seed 1946
1948	2	100	......	94.4	88.0	Seed 1947
Lake City, seed 1944						
1945	1	100	125.5	98.4	72.9	All exc., no grass
1946	1	100	109.0	88.4	82.0	Good alfalfa, considerable grass
1947	1	100	77.7	82.4	67.8	Good alfalfa, considerable grass
1948	1	100	102.0	90.0	70.7	Fair alfalfa, much grass

Lansing Experiment Stations. Table 7 shows the yields on a percentage basis, using Michigan grown Grimm as the standard.

DISCUSSION

Throughout this field-testing program, various alfalfas have been tested, beyond those mentioned in this report. In all, the conclusion has been reached that none of the "common" (purple-blossomed) alfalfas yield as well, or are as generally satisfactory as are Grimm and Hardigan. The new wilt resistant alfalfas have their place. Ladak may be fully equal to Grimm in general usefulness in the northern part of the state, even though it tends to be slow in recovery and poor in fall growth. In areas badly troubled by bacterial wilt of alfalfa, Ranger may equal Grimm by yielding more than Grimm after the first two years. Buffalo alfalfa seems definitely out of its climatic range in most of Michigan, although it is highly resistant to bacterial wilt, and is

apparently a good alfalfa when not injured by cold. All three of the new wilt-resistant alfalfas are less attractive, less green, poorer in blooming, and more troubled by leaf diseases than are Grimm and Hardigan. There is some suggestion that Grimm and Hardigan usually surpass them in seed production, although Ladak has in some cases looked good.

CONCLUSION

Michigan-grown Grimm and Hardigan seed is fully equal to any seed tested for most purposes in Michigan. If but one cutting is taken, Ladak may be superior in hay production, particularly in the north. Ranger can be expected to last longer in soil badly infested with bacterial wilt, particularly if the alfalfa is treated with caution to avoid winter injury.

In areas where winter injury is not a factor, the only reason for considering Buffalo rather than Ranger is that the seed of Buffalo is more readily obtained.

STORAGE OF PEACHES OF DIFFERENT DEGREES OF RIPENESS

By PAULINE PAUL AND M. E. CRAVENS, JR.
SECTION OF FOODS AND NUTRITION AND AGRICULTURAL ECONOMICS

PEACHES THAT ARE to be sold through normal commercial channels must be picked before they reach the soft-ripe stage so that the flesh of the peaches will be firm enough to prevent excessive bruising during picking, sorting, packing and shipping. The problem of how the peaches should be stored for ripening has been investigated by a number of workers. The results obtained differ somewhat with season, locality and type of peach. This paper is a report of a small study made on peaches grown in the Benton Harbor area in the 1948 season. It represents a continuation of the work reported previously (1) on room temperature storage of peaches.

Elberta peaches were obtained directly from the orchard. The peaches were picked by the regular commercial pickers, then hand-sorted into three levels of ripeness—green, hard-ripe and firm-ripe. None of the peaches was ripe enough to be classed as tree-ripe.

The peaches were transported to the laboratory, sorted into small baskets and stored at different temperatures as indicated in Table 1. The holding times at the various temperatures were determined by the number of peaches available and their condition during the test period. The small number of firm-ripe peaches available reduced the possible number of tests for this class. Lots held under refrigeration were changed to room temperature when it became obvious that they would not ripen sufficiently to be edible at the lower temperatures. At the time intervals indicated in Table 1, samples were peeled, sliced, and scored for general appearance, color, odor, flavor, texture and general conclusion. The average general conclusion scores are listed in Table 1. The maximum possible score was 7. Any sample receiving a general conclusion score of 3 or less was usually marked "unacceptable" by the judges.

ARTICLE 31-47

Room Temperature—(Lot 1) All the peaches held up satisfactorily for 6 days. The green and hard-ripe peaches improved up to 6 days, after which time the flavor, texture and general conclusion scores decreased, although the color scores remained high. At 2 days the firm-ripe peaches were given the highest scores, with hard-ripe next and green still lower. At 6 days the hard-ripe and green peaches received about equal scores, with the firm-ripe still slightly superior.

Room and Refrigerator—(Lots 2 and 9) These lots were intended to approximate conditions when the consumer purchases peaches which may or may not have been cooled at the packing plant, and then keeps the peaches in cool storage at home. The firm-ripe peaches which had not had preliminary chilling held up satisfactorily for 6 days, after which the flavor deteriorated, and the general conclusion score decreased. Chilling the samples for 2 days before holding at room temperature did not increase the storage life of the peaches materially over that of the non-chilled peaches. The green peaches showed definite improvement in color and texture during storage at 50° F., but the flavor did not improve.

Incubator—(Lot 5) The incubator was small and moisture produced by the respiration of the fruit created an atmosphere of high humidity as well as high temperature. The peaches improved in score for all factors up to 6 days, after which time the scores decreased again, with the exception of the texture of the green samples which continued to improve up to the 12th day. However, this improvement of texture was more than counterbalanced by loss of color and flavor. The hard-ripe sample at 6 days received the highest color score of the entire experiment. However, the firm-ripe peaches held at room temperature throughout were superior in flavor and texture.

Refrigerator, 32° F.—(Lots 6 and 8) One lot (No. 8) was removed from the refrigerator after 9 days, the other lot (No. 6) after 21 days. The peaches kept satisfactorily at 32° F., showing very little tendency to ripen at that temperature. All the samples improved when removed from refrigerator to room temperature. Those held 9 days at 32° F. were best after 5 days at 77° F., then deteriorated, especially in flavor. Of those held 21 days at 32° F., the hard-ripe peaches were satisfactory after 4 days at 77° F., but the green peaches did not develop sufficient flavor to be acceptable.

Refrigerator, 41° F.—(Lot 4) This lot was held at 41° F. for 10 days, then removed to room temperature. The hard-ripe peaches were

TABLE 1—*General conclusion* scores for peaches (maximum possible score 7)*

Lot No.	Location	Average temperature °F.	Stage of ripeness	Average general conclusion scores after days of storage indicated															
				2 days	3 days	4 days	6 days	7 days	9 days	10 days	12 days	13 days	14 days	16 days	17 days	19 days	21 days	23 days	25 days
1	Room	77°	Green	3.0		3.8	5.0			3.8	3.0								
			Hard-ripe	4.0		4.7	5.0			2.8									
			Firm-ripe	5.0		5.5	5.8												
2	Room and Refrigerator	77° for 3 days 50° rest of time	Firm-ripe		4.8		4.8		4.5			3.2							
4	Refrigerator and Room	41° for 10 days 77° rest of time	Green								3.2			4.0		2.0			
			Hard-ripe								3.6			2.0		1.6			
5	Incubator	90°	Green	1.8		2.5	4.0				3.2								
			Hard-ripe	2.0		4.5	5.6				3.4								
6	Refrigerator and Room	32° for 21 days 77° rest of time	Green			1.7			1.3			2.0			1.4		1.2	2.0	2.3
			Hard-ripe			2.5			2.2			2.2			1.6		1.6	2.3	3.7
			Firm-ripe			2.5			3.2			3.0			2.8		1.8		
7	Refrigerator	50°	Green			1.5			2.7			2.7							
			Hard-ripe			3.2			3.7			3.3							
			Firm-ripe			4.5			3.8			3.3							
8	Refrigerator and Room	32° for 9 days 77° rest of time	Green					1.2		2.8	3.0		4.5	3.3					
			Hard-ripe					1.8		2 3	4.8		5.3	4.3					
			Firm-ripe					2.4		4.7	5.2								
9	Refrigerator and Room	41° for 1 day 77° for 2 days 50° for 16 days 77° rest of time	Green		1.6		2.5		2.5			2.6				2.8		3.0	
			Hard-ripe		3.6		4.8		4.3			2.8				3.2			
			Firm-ripe		4.0		5.2		4.0			4.4							
10	Refrigerator and Room	50° for 9 days 77° rest of time	Green					2.2		3.2	3.8		4.3	3.7					
			Hard-ripe					3.2		3.2	4.4		4.0						
			Firm-ripe					4.2		4.2	3.8								

*The general conclusion score represents a comprehensive opinion of the eating quality of the peaches, including all the individual factors such as color, flavor and texture.

satisfactory after 2 days at 77° F., then became unacceptable because of low flavor scores. The green peaches continued to improve in all factors up to 6 days at 77° F., after which the scores decreased again.

Refrigerator, 50° F.—(Lots 7 and 10) Lot 7 was held at 50° F. for 13 days. The firm-ripe peaches decreased steadily in acceptability, owing to lowered flavor scores. The hard-ripe peaches remained about the same throughout the test period. The green peaches improved in color and texture, but only slightly in flavor, not enough to make any of these samples acceptable.

Lot 10 was removed to room temperature after 9 days at 50° F. All these samples improved in color and texture at room temperature. The flavor scores held up or continued to improve for the following lengths of time at room temperature: 1 day for the firm-ripe peaches, 3 days for the hard-ripe peaches, 5 days for the green peaches.

In General—Holding the peaches at room temperature gave the best overall results. Refrigeration lengthened the life of the peaches, but they were not quite as high in eating quality as those which were not refrigerated. The peaches stored under refrigeration tended to develop a mealy texture, as has been reported by other workers (2). This was more pronounced in the samples stored at 50° F. and those stored 21 days at 32° F. Of the samples refrigerated for part or all of the storage period, those held at 32° F. for 9 days, then at room temperature, gave the best results.

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HYBRID SUGAR BEETS IN MICHIGAN

By H. L. KOHLS
SECTION OF FARM CROPS

UNTIL RECENTLY it has been very difficult to make use of hybrid vigor to increase yields of sugar beets because of the large amount of self- and sib-pollinating that usually takes place. The morphology of the flower is such that it is impractical to emasculate a large number of flowers. Recently cytoplasmically inherited male-sterility has been found in sugar beets and it lends itself readily to mass hybridization.[1]

The Station received in 1945, from Dr. F. V. Owen of the Division of Sugar Plant Investigations, U.S.D.A., a few plants that were male-sterile. The plants were divided into five groups and each group was pollinated by a different inbred strain. The progeny from the male-steriles of each group was observed at flowering time, and of two of these hybrids one hybrid was 100 percent male-sterile and the other nearly so. These two hybrids were back-crossed to their respective pollen parents. The seed was again taken from the male-steriles. This seed was then planted in the field to produce a large number of roots for crossing the following year. These two female lines are known as Ac. 32–57301E_2 and Ac. 35–410603E_2. In 1947, 17 hybrids were made by pollinating these two female lines by other inbred male lines.

Previous to this work the author had attempted to cross Ac. 32–35701 with U. S. 216 but failed because of the low percentage of crossing that took place. He did, however, observe that a few plants were very large and vigorous and appeared to be very desirable hybrids. Therefore in 1945, when male-sterile plants were available, he started to develop a male-sterile strain equivalent to Ac. 32–57301 to be crossed with U. S. 216. This was accomplished in 1946 and in the same year arrangements were made with the Farmers and Manufacturers Beet Sugar Association to pollinate this strain with U. S. 216 for a commercial hybrid of sugar beets. This cross is known as Hybrid 125.

[1]Cytoplasmically Inherited Male-sterility in Sugar Beets, by F. V. Owen. Jour. Agr. Res., *71:* (10) Nov. 15, 1945.

ARTICLE 31-48

TABLE 1—*A comparison of hybrids 125 and 148 and their parents at Blissfield, Michigan, in 1948. The data are in terms of U. S. 215 x 216/3 as 1.00*

Variety		Tons per acre	Percent sugar	Percent purity	Recover-able sugar per acre	Smooth-ness of root	Resist-ance to leaf spot
Ac. 32–57301 E[2]	female. .	.59/	.95	.99	.57/	1.01	.99
Hybrid 125	hybrid. .	1.12‡	.97	.99	1.11‡	1.00	.90/
U. S. 216	male. . . .	.90*	1.00*	1.00*	.90*	1.00*	.95*
Ac. 35–410603 E[2]	female. .	.66/	.96	1.00	.51/	.95≠	.98
Hybrid 128	hybrid. .	1.19‡	.94/	.99	1.10	.98	.99
Ac. 32–57305	male. . . .	.57/	.94/	1.01	.53/	1.02	1.03†

†Statistically significant above the standard at the 5% level.
‡Statistically significant above the standard at the 1% level.
≠Statistically significant below the standard at the 5% level.
/Statistically significant below the standard at the 1% level.

*No data are available but estimates were made from previous observations.

Hybrid 125 and the 17 hybrids referred to previously were tested in suitable 6-by-6 Latin squares at Blissfield, Michigan, in 1948. Two hybrids, 125 and 148, were found to be very desirable in comparison to the commercial variety commonly grown in the state. Table 1 shows the hybrid vigor of these two hybrids as exhibited by their relatively high yields per acre.

Hybrid 125 was tested in nine locations in the eastern sugar beet area in comparison with U. S. 215 x 216/3, the commonly grown commercial variety.[2] Eight-by-eight Latin squares were used except at Blissfield where a 6-by-6 planting design was used and at East Lansing on muck soil the design was a randomized block replicated four times. In this paper all varieties are omitted except Hybrid 125, U. S. 215 x 216/3 and the "Muck Variety" because they have no bearing on the data, to be reported. The Muck Variety was included in only one test.

Table 2 gives the comparative data involving Hybrid 125 from 9 tests in the eastern sugar beet area. On muck soil at East Lansing Hybrid 125 was higher yielding than the commercial and the Muck Variety but the Muck Variety was higher than the other two in percentage of sugar. There was no difference between the three in recoverable sugar per acre. At Reese there was no difference between the hybrid and the commercial. But in the other seven tests Hybrid 125 outyielded the commercial in both tonnage and pounds of recoverable sugar per acre. In all tests, Hybrid 125 averaged 12½ percent more

[2]Cooperators in these tests include G. H. Coons and J. G. Lill, Division of Sugar Plant Investigations, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture; Perc A. Reeve and Grant Nickol, Farmers and Manufacturers Beet Sugar Association; Paul M. Harmer and John F. Davis, Soil Science Department, Michigan State College; H. H. Heilman, Great Lakes Sugar Co. and B. E. Easton, Canada and Dominion Sugar Co.

TABLE 2—*A comparison of hybrid 125 and U. S. 215 x 216/3 as grown in several Michigan locations in 1948*

Location and variety		Tons per acre	Percent sugar	Percent purity	Recoverable sugar per acre in lbs.	Smoothness of root	Resistance to leaf spot
Old Fort, Ohio	H 125	25.27‡	17.10	81.66	7053†	....	....
	215 x 216	22.66	17.04	82.34	6441	......	......
Latty, Ohio	H 125	21.78‡	18.19	82.68	6551‡	....	....
	215 x 216	18.93	18.19	83.07	5716	....	....
East Lansing, Michigan	H 125	8.77‡	16.46	82.52	2385	......	....
	215 x 216	7.23	15.94	81.58	1895	......	....
Merrill, Michigan	H 125	18.74‡	18.22	81.75	5584‡	....	....
	215 x 216	15.79	18.28	82.63	4775	....	....
Saginaw, Michigan	H 125	17.77‡	19.49	85.33	5909	......	....
	215 x 216	15.31	19.00	84.49	4915	....	....
Reese, Michigan	H 125	18.17	19.39	85.08	5986	..	.....
	215 x 216	18.72	19.32	84.92	6169	....	......
Chatham, Canada	H 125	9.38†	17.06	....	3165†	....	.....
	215 x 216	8.22	17.14	....	2797	......	......
East Lansing, Michigan (on muck soil)							
	H 125	21.69‡	14.33	86.09	5355	....	....
	Muck variety	17.60	17.33‡	87.49	5345	......	.....
	215 x 216	19.03	14.40	85.66	5009	.....	....
Blissfield, Michigan	H 125	20.39‡	15.97	90.51	5928†	8.42	8.00/
	215 x 216	18.16	16.39	90.97	5326	8.38	8.92
Average of all locations	H 125	18.00‡	17.36	84.45	5324‡	....	....
	215 x 216	16.01	17.29	84.46	4779	......	.....

†Statistically significant above the standard at the 5% level.
‡Statistically significant above the standard at the 1% level.
#Statistically significant below the standard at the 5% level.
/Statistically significant below the standard at the 1% level

in tonnage and over 11 percent more in recoverable sugar per acre. It was not so resistant to leaf spot as the commercial.

The data presented here indicate that the use of cytoplasmically inherited male-sterility is a practical method of mass hybridization of sugar beets. This opens a large field for sugar beet improvement, particularly in increased yields due to hybrid vigor. It is now possible to get 100 percent crossing between strains and make full use of hybrid vigor, a thing that was not possible by previous methods. In the future—when a greater number of male-sterile inbred lines are available from which to select, and when a much greater number of combinations between strains can be made—breeders can reasonably expect to find hybrids that will be far more productive than those of today.

CONSUMER RESPONSE TO CHICKENS IN 1948

By H. E. LARZELERE and J. B. LEAVER[1]
ECONOMICS SECTION

THE PRODUCTION and marketing of broilers and friers were one of the 4-H Club projects in Kent County, Michigan in 1948. In August, about 2,500 of the chickens were feather-dressed (New York dressed) in a modern poultry dressing plant and sold at retail by a chain store organization through its outlets in western Michigan. As part of a complete appraisal of the project, a questionnaire was developed to give purchasers of the chickens an opportunity to indicate some of their general preferences in buying chickens and to express their ideas regarding the particular chickens which they obtained. The analysis of the results of these questionnaires had two objectives: 1) to assist poultry processing plants and retail establishments who handle chickens to satisfy the preferences of the eventual consumers, and 2) to serve as a guide for these young poultrymen in their future poultry production and marketing enterprises.

While no information has been obtained which could link certain preferences to such factors as personal income, race, or religion of the various consumers, the writers feel that the attitudes reported here will fairly well indicate the ideas regarding chickens of a large number of consumers in the area.

One hundred and fourteen purchasers returned questionnaires. The questions and answers are given in the following tables and form the basis of this report.

TABLE 1—*How long has it been since you bought a chicken?*[2]

Reply to Question	Percent
A few days	8
A week	32
Over a week but less than a month	29
A month or more	27
Did not answer question	4
Total	100

[1]The writers acknowledge the assistance given in this survey by the following agencies and persons: the Kent County Extension Office, the cooperating retail chain store organization; J. M. Moore, Poultry Husbandry Department; E. A. Shuler, Sociology and Anthropology Department, Michigan State College; and the consumers who returned the questionnaires.

[2]The title of each table in the report represents one of the questions on the questionnaire.

TABLE 2—*Why haven't you bought chicken more often?*

Reply to Question	Percent	Percent of those giving a reason
Too expensive	20	27
Could not get desired kind	18	24
Do buy often	12	17
Like variety	10	13
Other reasons	14	19
Did not answer question	26	..
Total	100	100

Table 1 indicates that well over half of the consumers answering the questionnaire had not purchased a chicken within a week. The reasons for not buying chicken more often are given in Table 2.

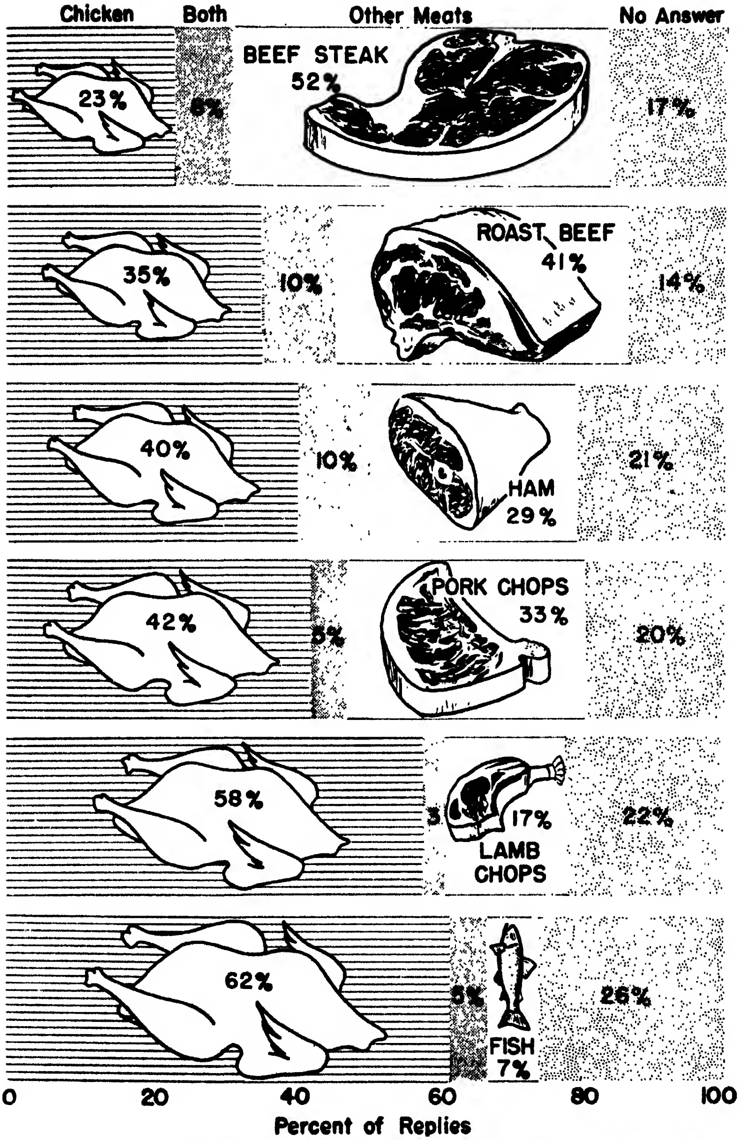
More than a fourth of the consumers who gave a reason for not buying chicken more often felt chicken was too expensive a meat, whereas slightly less than a fourth reported they could not get the desired quality. This latter observation, particularly, is a challenge to both poultry producers and marketing agencies.

In order to learn their preference regarding chicken and other meats, the consumers just mentioned were asked to choose between chicken and each of six other kinds of meat (or fish). The results are shown in Fig. 1 and indicate that chicken is preferred to pork chops, lamb chops, ham, and fish, but that roast beef and beef steak[3] are preferred over chicken. It must be emphasized, however, that these selections were made regardless of cost. Therefore, taking into account the previous observation that some consumers felt that chicken was too expensive, some folks would likely purchase a less expensive type of meat, even though chicken was preferred.

TABLE 3—*How did this chicken look to you before cooking? (Check one in each column)*

Replies	Percent	Replies	Percent
Very clean	79	Very plump	3
Fairly clean	16	Plump	84
Not clean	2	Thin	10
Did not answer	3	Did not answer	3
Total	100	Total	100
Very few feathers	85	Too much fat	0
Too many feathers	4	Fair amount of fat	90
Did not answer	11	Not enough fat	3
		Did not answer	7
Total	100	Total	100

[3]This group of consumers was selected because they had purchased a chicken. They might, therefore, tend to emphasize the popularity of chicken more than would the so-called average consumer.



*"Both" refers to the percentage of respondents who apparently liked both chicken and the respective meat (or fish), but did not wish to make a choice of one or the other.

Fig. 1. Preference in response to the question, "In each of the following pairs, check the meat that seems to be most popular with your family, regardless of cost."

The attitude toward the condition of the particular bird which the customer purchased can be observed in Table 3. The great majority of the customers felt that the 4-H club chickens which they obtained were very clean, had few feathers left on the carcass, were satisfactorily plump, and had a reasonable amount of fat. In addition, 15 voluntary comments appeared and all were complimentary. To illustrate, three are quoted below.

"I purchased 4 of your fryers—my one regret is these 4-H Club birds are not available to us all year around. They were delicious."

"I bought 2 last week for the first time and they were the cleanest I ever got in a market before. And they were nicely filled out and very tasty. I'm glad to let you know this. Thank you."

"The '4-H Tag' on the chicken was what drew my attention, and my faith in the products of the members of the organization was not misplaced. The chicken was plump, juicy, and delicious."

These responses indicate that these particular chickens met with great satisfaction as far as their purchasers were concerned.

TABLE 4—*What kind of chicken do you prefer? (Check one in each column)*

Replies	Percent	Replies	Percent
Plumper than this one	24	More fat than this one	9
About like this one	73	About like this one	81
Less plump than this	0	Less fat than this	1
Did not answer	3	Did not answer	9
Total	100	Total	100

Table 4 indicates that most of the respondents would like to obtain regularly chickens equal to these 4-H club birds. A few would have preferred a plumper and/or fatter chicken than the one they obtained. More than three-fourths of the consumers preferred the springer-type chicken to any of the others; however, the opinion of the particular purchasers of these chickens may have been biased. It should be recalled that all of these chickens were of the springer type, therefore, consumers who preferred other types probably would not have bought one of these chickens and would not have received a questionnaire. As to preparation of chicken, more than 60 percent preferred the frying method. The customers answering this questionnaire, however, again may have been inclined to favor the frying method because of their purchase of this type of chicken.

TABLE 5—*What way of preparing chickens is most popular with your family?* More than one answer could be given.*

Replies	Percent
Fry	61
Roast	24
Stew	6
Steam	2
Boiled—then fried	4
Uncertain	3
Total	100

In answer to the question "If you had your choice regardless of cost, which (one or more parts) would you buy?", 68 percent of the purchasers would buy a whole chicken alone or along with one or more selected parts. Fifty-four percent would purchase drumsticks or thighs, and 40 percent breasts alone or along with other parts. In contrast only 10, 7, and 3 percent would buy wings, giblets, and backs, respectively. These figures indicate some of the preferences in buying chicken meat by the piece. They also show the relative amount of differences that would be expected among prices for whole chickens and those for various parts.

In indicating the preference for purchasing their chicken, 40 per-

TABLE 6—*If you had your choice, which one way would you prefer to buy your chickens? Why do you prefer it this way?*

Preference	Number of purchasers	Reason	Number of purchasers
Live	4	Like to fix it to suit self	2
		Fresher	1
		Reason not given	1
Live-dressed and drawn while you wait	29	Fresher	20
		Better flavor	9
Drawn while you wait	28	Fresher	11
		Rather cut to suit self	8
		Know what you're getting	3
		Only way available	2
		Reason not given	4
Whole, ready to cook	18	Fresher	4
		Convenient	6
		Rather cut it to suit self	5
		Reason not given	3
Whole and frozen	1	Reason not given	1
Cut up, ready to cook	31	More convenient	25
		Do not like to clean it	4
		Reason not given	2
Cut up and frozen	3	Convenient	2
		Fresher	1

*The replies indicated 76 percent preferred springers, 16 percent hens, and 8 percent other types.

cent of the customers preferred to buy them ready-to-cook, either whole or cut-up, whereas approximately one-fourth of the customers preferred them to be only feather-dressed until they had seen them and waited for them to be drawn. More than one-fourth preferred to see the chickens alive at the time of buying. The reasons given for these various choices are shown in Table 6.

Consumers preferring to buy either as live, or live-dressed-and-drawn while you wait, or drawn-while-you-wait, believed that chicken, bought in these ways would be fresher and therefore more desirable. On the other hand, those preferring to buy the chickens in a dressed and ready-to-cook manner, did so because of the element of convenience.

TABLE 7—*If the price for a chicken sold on a ready-to-cook weight basis were about 20 cents per pound above the price for a similar chicken sold on an undrawn weight basis, which would you prefer to buy?*

Replies	Percent
Buy on the ready-to-cook weight......	59
Buy on the undrawn weight..........	37
Uncertain..........................	4
Total..................	100

Nearly 60 percent of the purchasers preferred to buy the chicken on a ready-to-cook weight basis if the price were 20 cents a pound above the price for a similar chicken sold on an undrawn weight basis. The render will observe that in answering this last question, more people preferred to buy on a ready-to-cook weight basis than was indicated in Table 6. Apparently, the use of a definite differential influenced their choice in this matter. The 20-cent difference in price between the price per pound for the ready-to-cook weight and the undrawn-weight was the customary differential during the time of this study. It was estimated that this differential made the net cost to the purchaser for the edible portions of the chicken about the same regardless of the method of sale. It should be recalled that generally when the chicken is bought on an undrawn-weight basis, the retailer draws the chicken after the customer has made his selection and the buyer therefore receives only the ready-to-cook portions.

Under these conditions, it would be immaterial to the retailer which method of sale was used. However, the ready-to-cook method would permit the retailer to have the drawing process done more economically

at a poultry dressing plant or at least during slack business hours and not take the time of a salesman-clerk at the time of actual purchase when other customers are waiting.

In summary: **First,** consumers would purchase more chickens if there were more birds readily available that have the meat quality and market preparation of the chickens concerned in this project.

Second: More chickens could also apparently be sold if methods were found to make them less expensive to the consumer as compared with other meats.

Third: A larger proportion of chickens of desirable quality could be sold on a ready-to-cook-weight basis and thereby probably effect some economies in retailing costs. This method of sale would be more popular, especially, if the purchaser felt that he paid no more for the edible portion of the bird than if he had purchased it on some other basis.

THE EFFECT OF METHOD OF PROCESSING ON EATING QUALITY AND VITAMIN C RETENTION OF PEAS

By MABEL LOU PIAN and PAULINE PAUL
SECTION OF FOODS AND NUTRITION

THE QUESTION of proper food preservation is of interest to all homemakers. There are four principal methods by which food may be preserved: 1) salting, 2) canning, 3) drying, and 4) freezing. Each method has its own advantages and disadvantages. The purpose of this study was to compare the eating quality and vitamin C retention of peas preserved by these four different ways.

EXPERIMENTAL PROCEDURE

The peas used were grown on the Research Farm of the Michigan State College. They were firm and ripe when processed.

The processing methods used followed standard recommendations (1, 2, 3, 5). Details are given in Table 1. Samples were scored for palatability and tested for vitamin C content at the following stages: fresh; freshly processed (no storage); after 3 months' storage. The method of analysis used for vitamin C was that of Loeffler and Ponting (4) for reduced ascorbic acid.

Samples of each lot of peas were cooked and scored to determine the eating quality. Scoring factors considered included appearance, color, odor, flavor, texture and general conclusion. The scoring scale ranged from 1 to 7, 1 being very poor and 7 excellent.

RESULTS

The average scores for the peas are given in Table 2. The frozen peas were given the highest scores throughout, with the canned peas second. The dehydrated and the salted peas were not acceptable when eaten alone, although several of the judges commented that they would have been satisfactory if combined with other foods as in soup or stew.

ARTICLE 31-50

TABLE 1—*Methods used in preparation of peas*

Method of Processing	Preparation	Pre-heating	Processing	Storage	Preparation for Scoring
Canning	Shell and wash	Bring to boil	Pack in pint jars, process 40 minutes at 10 pounds pressure	3 months at room temperature	Bring to boil, serve hot
Freezing	Shell and wash	2½ minutes in steam, cool in running water	Pack in pint cartons, seal, freeze at 0°F.	3 months at 0°F.	Cook ⅔ pound peas in ¾ cup water, 2 minutes, serve hot
Dehydrating	Shell and wash	5 minutes in boiling water	Spread on shallow trays, dry at 175-195°F. with fan on until dry enough to shatter (about 14 hours). Pack in pint jars	3 months at room temperature	Soak 1½ cups dried peas in 2½ cups water for 30 minutes. Boil 20 minutes, serve hot
Salting: I (in the pod)	Mix 9 pounds unshelled peas and 1 pound salt. Cover with brine of 1½ pounds salt and 1 cup vinegar to 1 gallon of water. Let stand 2 weeks	None	After 2 weeks, shell peas, repack in pint jars, cover with same brine	3 months at room temperature	Soak overnight in 1 gallon water to 1 pound shelled peas. Drain, cover with fresh water, bring to boil, serve hot
II (shelled)	Shell and wash	None	Mix 1½ pounds salt with 8 pounds shelled peas, cover with brine of 1½ pounds salt, 1 cup vinegar and 1 gallon water, pack in pint jars	3 months at room temperature	Same as for I

TABLE 2—*Average scores for peas (maximum possible score, 7)*

Method of processing	Length of storage	Scoring factor: Appearance	Color	Odor	Flavor	Texture	General conclusion
Canning.......	None....	5.0	3.8	4.6	4.2	4.5	4.3
	3 months	4.9	4.8	4.0	4.4	4.4	4.3
Freezing.......	None	5.7	5.7	5.5	5.5	5.0	5.6
	3 months	6.3	6.3	5.8	5.3	4.8	5.5
Dehydrating...	None	4.0	4.2	4.5	3.9	2.6	2.6
	3 months	3.3	3.3	2.9	3.0	2.0	2.3
Salting (in the pod) I	None	5.6	4.2	4.4	2.8	3.7	3.4
	3 months	5.2	5.2	2.7	3.4	3.3	3.0
(shelled) II...	None	4.4	4.0	3.3	1.9	4.2	2.2
	3 months	5.3	4.9	2.9	2.2	4.5	2.7

The percent of vitamin C retained in the various samples is shown in Table 3. Again, freezing gave the best results. Salting in the pod gave the next best, and canning was third. Leaving the peas in the shell during part of the salting process probably helped to reduce the loss by solution of vitamin C.

TABLE 3—*Vitamin C values for peas (percent of original content)*

Method of Processing	No storage	3 months' storage
Canning	32.0	26.7
Freezing	59.6	89.8
Drying	27.9	0.0
Salting (in the pod) I	50.0	39.1
(shelled) II	20.5	20.2

SUMMARY

A comparison has been made of the eating quality and vitamin C content of peas preserved by canning, freezing, drying and two methods of salting.

Frozen peas gave the best results, both for eating quality and for retention of vitamin C. Canned peas were second for eating quality, and peas salted in the shell were second for vitamin C retention. Although the judges did not like the dried or salted peas when served plain, they thought these peas would be acceptable when mixed with other foods.

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CUSTOM RATES CHARGED FOR FARM WORK IN MICHIGAN IN 1948

*By B. R. BOOKHOUT and R. W. CHRISTIAN**
SECTION OF FARM MANAGEMENT

MANY REQUESTS have come to the Farm Management Department, asking for information on current custom rates. The rates shown in this report were obtained from reports sent in by over 500 Michigan farmers doing custom work.

Custom work is one method of solving the problem of making fewer machines serve more farmers. Custom work enables the operators of smaller farms to obtain the efficiency of large machines which they could not afford to buy. Other methods are sharing work and owning machinery jointly.

The use of custom work by Michigan farmers has increased in the last few years. Farm machinery and labor have been scarce during the years of the war and post-war period. Farm equipment is now available but at prices above the pre-war levels. Many farmers are looking to custom work as a means of getting the work done without an investment in machinery out of line with their farm business. Other farmers have purchased large machines and are looking for work on a custom basis to help carry the high investment and, in many instances, to supplement the farm income.

Many farmers reported only one or two types of custom work. One farmer might report work with a combine and a plow or disk. Another farmer might report custom baling. Some of the reports, however, gave rates for work with many types of farm equipment. These operators evidently regard custom work as a major source of income rather than as a means of spreading costs or supplementing the farm income.

The "most common rate" for the usual sizes of farm equipment are listed in this report. Some farmers reported rates below and some above these common rates. The lower rates were usually accompanied

*The authors appreciate the cooperation of the farmers who gave the information, and the assistance of the County Agricultural Agents and other members of the Farm Management Department.

ARTICLE 31-51

with a note such as, "level field", "good going", or "no stones". The higher rates were frequently near cities where the wage rates and other costs tend to be higher. The higher rates were also reported for difficult field conditions. For example, many farmers reported a charge of 50 cents more per acre for plowing alfalfa sod, stony ground, or rough fields.

The "usual range" shown in the tables covers at least two-thirds of the rates reported for a given job. Some of the very high and very low rates were for unusual conditions and were not included in the usual range.

Custom work rates in the southern half of the lower peninsula were reported mostly on an acre basis. In the northern part of the lower peninsula and the upper peninsula, the rates were usually given on an hourly basis. In general, the acre rates were used where field conditions were fairly uniform from farm to farm. Where there was greater difference in field conditions, the hourly rates made a fairer basis for custom work payments.

The size of the machine had little effect on the custom rates on an acre basis. On an hourly basis, however, the rates varied with the size of the machine. Larger machines have a greater cost but do more work per hour. Thus, their rates per hour are higher, but the charges per acre remain about the same.

PLOWING, FITTING AND CULTIVATING

TABLE 1—*Plowing, fitting, and cultivating custom rates in 1948 (Rates include machine, tractor, and operator)*

Operation	Acre rate		Hourly rate		Average acres per day
	Most common rate	Usual range	Most common rate	Usual range	
Plowing					
2-bottom	$4.00	$3.50–4.50	$3.00	$2.50–3.50	8
3-bottom	4.00	3.50–4.50	4.00	3.50–4.50	12
Disking					
7-foot and under	1.00	0.75–1.25	3.00	2.50–3.50	21
8-foot and over	1.00	.75–1.50	3.50	2.50–4.00	28
Dragging					
2-section	1.00	.75–1.25	3.00	2.50–3.50	25
3-section	.75	.50–1.00	3.00	2.50–3.50	36
4-section	.75	.50–1.00	3.00	3.00–3.50	40
Field cultivating					
All machines	1.25	1.00–1.50	2.50	2.00–4.00	11
Cultivating					
2-row	1.00	.75–1.50	3.00	2.50–3.00	20
4-row	1.00	.75–1.50	....	....	28

DRILLING AND PLANTING

TABLE 2—*Drilling and planting custom rates in 1948 (Rates include machine, tractor, and operator except as noted for planting potatoes)*

Operation	Acre rate: Most common rate	Acre rate: Usual range	Hourly rate: Most common rate	Hourly rate: Usual range	Average acres per day
Grain drilling					
13-hole or under					
without fertilizer	$1.50	$1.00–1.50	$3.00	$2.50–3.00	20
with fertilizer	1.50	1.00–2.00	3.00	2.50–3.50	20
14-hole or over					
without fertilizer	1.50	1.00–1.50	3.00	2.50–3.50	24
with fertilizer	1.50	1.25–2.00	3.00	2.50–3.50	24
Bean drilling					
2-row	1.75	1.50–2.00	2.50	2.50–3.00	15
4-row	1.50	1.00–2.00	....	....	24
Grain drill	1.50	1.25–1.50	....	....	25
Corn planting					
2-row					
without fertilizer	1.25	1.00–1.50	3.00	2.00–3.50	20
with fertilizer	1.50	1.25–2.00	3.00	2.50–3.50	17
4-row					
without fertilizer	1.50	1.00–2.00	....	....	30
with fertilizer	1.50	1.25–2.00	....	....	25
Potato planting					
1-row—operator only	....	....	2.00	2.00–2.50	6
2-row—operator only	3.50	2.50–4.00	4.00	3.50–4.50	11
2-row—operator and 1 man	4.00	3.50–4.00	4.00	3.00–5.00	10

SPRAYING AND DUSTING

The rates for spraying row crops and fruit varied with the size of the spray tank, the capacity of the pump, and the number of men furnished. The rates in the foregoing table include sprayers of different sizes and capacities. Therefore the rates should be considered as

TABLE 3—*Spraying and dusting custom rates in 1948 (Rates include sprayer, tractor, and operator except as noted)*

Operation	Basis of charge	Most common rate	Usual range
Spraying potatoes	Hour	$3.00	$3.00–4.00
	Acre	2.00	1.50–2.50
	Gallon	0.02	.01½–.02
Dusting potatoes	Acre	1.50	1.25–2.00
Spraying tree fruit			
1 man furnished	Hour	3.50	3.00–5.00
2 men furnished	Hour	4.00	4.00–5.00
All	Gallon	.02	.01½–.02½
Spraying small fruit	Acre	....	2.00–3.00
Spraying weeds with 2,4-D			
Material included	Acre	4.00	3.00–5.00
Material not included	Acre	2.00	1.50–2.50

guides rather than definite standards. Most custom operators varied the rates, depending on the size of the job, ease of obtaining water, topography of the orchard, size of trees, and other factors that affect the amount of spray that can be applied in a given time.

The custom rates reported for the newer types of work such as field chopping, loading manure with a tractor loader, and spraying with 2,4-D for weed control varied more than the rates for work with more conventional types of equipment. The rates for these newer jobs are likely to change as farmers become more familiar with the equipment.

MOWING AND RAKING HAY

TABLE 4—*Mowing and raking custom rates in 1948 (Rates include machine, tractor, and operator)*

Operation	Acre rate		Hourly rate		Average acres per day
	Most common rate	Usual range	Most common rate	Usual range	
Mowing hay					
5-foot mower	$1.00	....	$2.50	$2.00–2.50	9
6-foot mower	1.25	$1.00–1.50	2.50	2.00–3.00	19
7-foot mower	1.00	1.00–1.50	3.00	2.50–3.50	26
Raking hay					
Side delivery rake	1.25	1.00–1.25	2.50	2.00–3.00	26

FIELD CHOPPING

TABLE 5—*Field chopping custom rates in 1948*

Operation	Hourly rate		Average acres per day
	Most common rate	Usual range	
Hay chopping			
Chopper and blower with:			
1 man—2 wagons—1 tractor	$8.00	$7.00–10.00	9
2 men—2 wagons—2 tractors	10.00	10.00–12.00	18
2-4 men—trucks—2 tractors	12.00	10.00–12.00	....
Straw chopping			
Chopper and blower with:			
1 man—2 wagons—1 tractor	8.00	7.00–10.00	16
2 men—2 wagons—2 tractors	10.00	8.00–12.00	18
Corn chopping			
Chopper and blower with:			
1 man—2 wagons—1 tractor	8.00	8.00–10.00	8
1 man—2 wagons—2 tractors	9.00	8.00–10.00	....
2 men—2 wagons—1 tractor	8.00	8.00–10.00	9
2 men—2 wagons—2 tractors	10.00	10.00–12.00	8
2 or 3 men—trucks—2 tractors	10.00	10.00–12.00	....

The reports for field chopping did not give complete information on the size of chopping equipment. However, from the information received the hourly rates were slightly higher for the larger machines. There was little difference in the acre rates but the larger machines covered great acreages per day.

A few farmers with field choppers reported a charge per hour for the use of the equipment in the field and a charge per foot for the equipment used at the silo. The usual rates reported were $6.50 per hour for the field work and $1 to $2 per foot for filling silo.

CUTTING GRAIN AND THRESHING

TABLE 6—*Cutting grain and threshing custom rates in 1948 (Rates include machine, tractor, and operator)*

Operation	Acre rate		Average acres per day
	Most common rate	Usual range	
Grain cutting			
6-foot binder	$2.00	$1.50–3.00	12
7-foot binder	3.00	2.00–3.50	13
8-foot binder	3.00	2.00–3.50	16
10-foot binder	2.00	1.50–2.50	19
	Rate per bushel		
Threshing			
Wheat	$0.08	$0.06–0.10	
Barley	.07	.06– .08	
Oats	.06	.05– .07	
Rye	.08	.08– .10	
Beans	.20	.15– .25	
Alfalfa seed	2.50	1.50–3.50	
Clover seed	2.50	1.50–3.50	

Threshing rates for alfalfa and clover seed were also reported on an hourly basis and on the basis of weight of seed. In some cases the yield of seed determined the basis of charge. The usual rates per hour were $5, but the reports ranged from $4 to $6 per hour. On the basis of weight, the rates reported were from 4 to 6 cents per pound.

COMBINING

Combining alfalfa and clover seed for a share of the seed was reported by about 10 percent of the farmers who combined these crops. The usual share was one-half of the seed, but a few reported a one-third share, especially when the yield was high.

TABLE 7—*Combining custom rates in 1948 (Rates include machine, tractor, and operator)*

Operation	Acre rate		Hourly rate		Average acres per day
	Most common rate	Usual range	Most common rate	Usual range	
Small Grain					
3½ to 4½ foot combine	$5.00	$4.00–6.00	$4.50	$4.00–5.00	8
5-foot combine	5.00	4.00–6.00	5.00	4.00–6.00	11
6-foot combine	5.00	4.00–6.00	6.00	5.00–6.00	12
7 to to 12-foot combine	5.00	4.00–6.00			
Field beans					
5-foot combine	5.00	4.00–5.00	....	....	11
6-foot combine	5.00	4.50–6.00	4.00	....	11
Special bean combine	6.00	6.00–7.00	....	....	18
Soybeans					
5-foot combine	5.00	4.00–5.00	....	....	11
6-foot combine	5.00	4.00–5.00	....	....	12
Alfalfa seed					
3½ to 4½-foot combine	5.00	4.50–5.00	....	....	8
5-foot combine	5.00	4.00–5.00	5.00	5.00–6.00	9
6-foot combine	5.00	4.00–5.00	5.00	5.00–6.00	10
7 to 12-foot combine	5.00	4.00–6.00	....	....	13
Clover seed					
3½ to 4½-foot combine	5.00	4.00–5.00	....	....	8
5-foot combine	5.00	4.00–5.00	5.00	4.00–6.00	9
6-foot combine	5.00	4.00–5.00	5.00	5.00–6.00	10
7 to 12-foot combine	5.00	4.00–5.00	....	....	16

FIELD BALING

TABLE 8—*Field baling custom rates in 1948 (Rates include machine, tractor, and operator except as noted)*

Baler and crew	Baling hay			Baling straw		
	Most common rate	Usual range	Average tons per day	Most common rate	Usual range	Average tons per day
Automatic baler						
Rectangular bale						
String tie:						
with towed wagon	$0.12	$0.12–0.13	27	$0.13	$0.12–0.14	17
without towed wagon	.12	.10– .14	27	.12	.10– .14	21
Wire tie	.13	.10– .14	34	.15	.14– .15	20
Round bale—string tie	.12	.10– .13	23	.12	.10– .12	20
3-man baler						
Operator and 2 men:						
with towed wagon	0.15	0.14–0.16	23	0.15	0.14–0.16	16
without towed wagon	.14	.12– .15	24	.15	.13– .16	17

Towing a wagon behind the baler was reported by 23 percent of the operators of automatic string tie balers. Thirty-six percent of the reports for 3-man balers included a wagon towed behind the baler.

PICKING CORN AND FILLING SILO

TABLE 9—*Picking, cutting, shredding corn, and filling silo custom rates in 1948 (Rates include the machine, tractor, and operator except as noted)*

Operation	Acre rate		Hourly rate		Average acres per day
	Most common rate	Usual range	Most common rate	Usual range	
Corn picking					
1-row picker	$5.00	$4.00–6.00	$5.00	$4.50–5.00	8
2-row picker	4.00	4.00–5.00	....	....	14
Corn cutting					
Binder only	4.00	3.00–5.00	3.50	3.00–4.50	8
Binder with loader	4.00	3.00–5.00	5.00	4.50–5.00	8
Corn shredding					
Operator only	....	....	4.00	3.50–4.50	....
Operator and 1 man	....	....	5.00	4.00–5.00	....
Silo filling					
All silos	....	....	4.00	3.00–5.00	
	Rate per foot				
10-foot silo	.75	.75–1.00			
12-foot silo	1.00	.75–1.25			
14-foot silo	1.00	1.00–1.25			

HARVESTING SUGAR BEETS

The use of mechanical sugar beet harvesters for custom work was reported by about 20 farmers. The most common rate reported was $20 per acre. Rates ranged from $15 to $27 an acre. About one-half of the farmers indicated that the rate was based on the yield and was the same as the cost of harvesting with hand labor. Some rates were given as a minimum of $15 to $17 with increases above this minimum based on the yield and hand labor rates.

The acreage of sugar beets harvested per day with mechanical harvesters averaged 4.2 acres a day. The reports ranged from a low of 2.5 acres to a high of 6 acres harvested a day.

SPREADING LIME

The usual practice reported for handling lime was to contract for the lime spread on the field. The price differs between areas since in most cases the price is determined by bids submitted by contractors. A contractor may bid to deliver lime at a given price within a given area. Outside that area, an additional charge per mile is added for trucking. In other areas, the contractor bids for the lime contracts, with mileage charges starting at the loading point with no base area.

The rates reported by 25 contractors and farmers for lime spread on the field averaged $3.85 per ton. The rates ranged from $3.50 to $5.00, depending mostly upon the hauling distance. Several reports gave the charge for spreading separate from the total charge. Rates for spreading were between 50 and 60 cents per ton in most cases.

OTHER CUSTOM WORK

TABLE 10—*Custom rates for other operations in 1948 (Rates include machine, tractor, and operator except as noted)*

Operation	Basis of charge	Most common rate	Usual range
Digging potatoes	Hour	$4.00	$3.00– 5.00
	Acre	6.00	5.00– 7.50
Picking potatoes	Bushel	0.08	0.08– 0.10
Loading manure with tractor loader	Hour	3.50	2.00– 5.00
Spreading manure	Hour	2.50	2.00– 3.00
Bulldozing	Hour	8.00	7.00– 9.00
Buzzing wood	Hour	2.50	2.00– 3.00
Sawing lumber	1,000 bd. ft.	15.00	12.00–18.00
Grinding feed	Bushel	0.06	....
Trucking			
General	Hour	3.00	2.50– 3.00

MACHINERY RENTAL

TABLE 11—*Machinery rental rates in 1948*

Machine	Basis of charge	Average rate	Usual range
Grain drill	Acre	$0.65	$0.50–1.00
Bean drill	Acre	.75	....
Corn planter	Acre	.85	.75–1.00
Potato planter	Acre	1.85	1.50–2.00
Lime spreader	Acre	.40	.30– .50
Conveyor			
Hay or straw	Bale	.01	....
Small grain	Acre	.75	.50–1.00
Ear corn	Acre	.75	.50–1.00
Tractor			
1-plow, alone	Hour	1.50	....
2-plow, alone	Hour	2.00	....
2-plow, with operator	Hour	2.90	2.50–3.00

TRACTOR VINE LIFTERS

By J. F. DAVIS and G. W. FRENCH

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IN THE PRODUCTION of many crops certain cultural treatments such as dusting, spraying and cultivating are necessary. Power equipment is generally used, and in some cases the operations are continued until the crop is mature. Unless provision is made for lifting the vines of certain crops they will be seriously injured by the wheels of the implements used and yields accordingly reduced.

In 1947 a set of vine lifters was built to fit a tractor in use at the Michigan Muck Experimental Farm. Although they were built for one specific make of tractor, it is thought that the design could be adapted to wheel tractors in general.[1] For this reason drawings with overall dimensions of the units are shown rather than detailed plans.

The contour and shape of the lifter is shown by the general view in Fig. 1.[2] The frameworks for the front and rear lifters are shown by Figs. 2 and 3. These drawings are presented to illustrate the mode of attachment and general overall measurement associated with these units.

The method of attachment of the lifter to the front wheel is shown by Figs. 4 and 5. The lifter is attached to the front wheel by a shaft welded to the inside of the spindle assembly and by a spider that fastens to the rim bolts. The axes of bearings A and B as shown in Fig. 2 are concentric.

The outside pivot for the rear lifter is illustrated by Fig. 6. For this specific mounting, a square plate was welded to the rivets in the wheel hub. In order to prevent damage to the wheel from overheating, this plate was first tack-welded with an electric arc welder. Additional welding at intervals was done until the plate was securely fastened. The pivot plate is bolted to this plate and can be readily removed

[1]Detailed working drawings are not available for the vine lifters because each make and model of tractor would require some modification in the design.

[2]These vine lifters were built by Paul Good, Mechanic, Michigan Muck Experimental Farm, and L. B. Vaughn, Buildings and Utilities Department, Michigan State College.

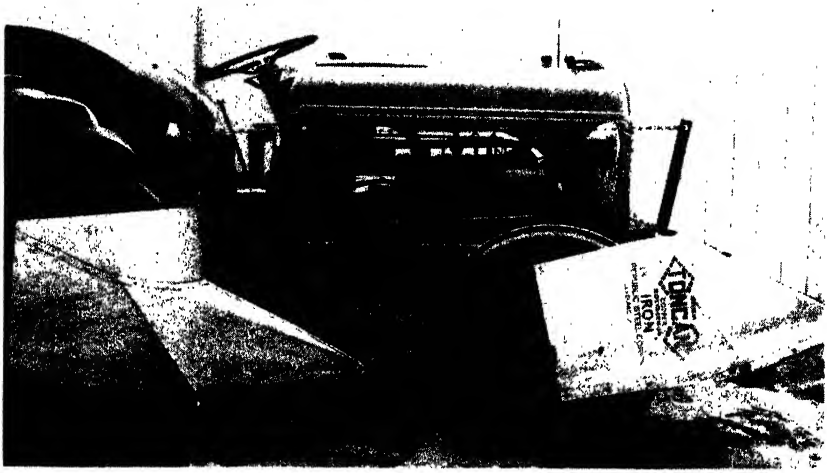

Fig. 1. General view of vine lifters.

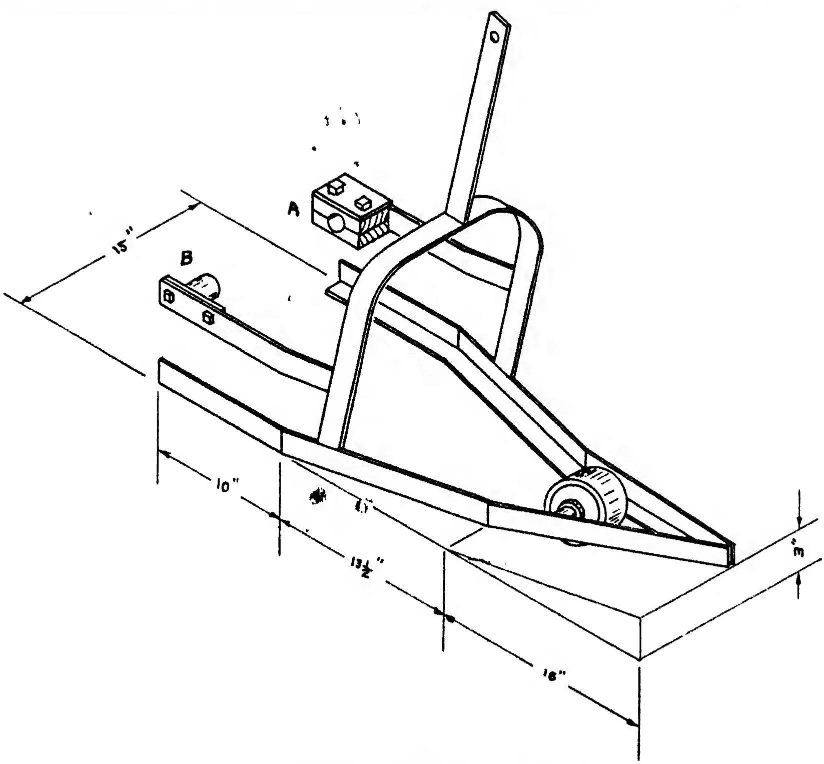

Fig. 2. Framework for left front lifter unit.

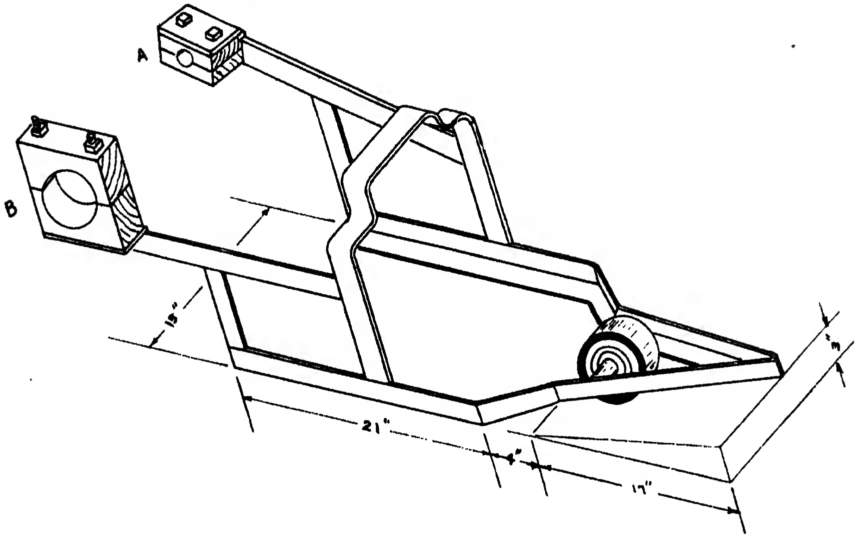

Fig. 3. Framework for left rear lifter unit. Outside pivot A is attached to the rear wheel as shown in Fig. 6. Inside pivot B is attached as shown in Fig. 7.

Fig. 4. Method of attachment of the front lifters to the outside pivot on the front wheel.

Fig. 5. Inside pivot for the front lifter.

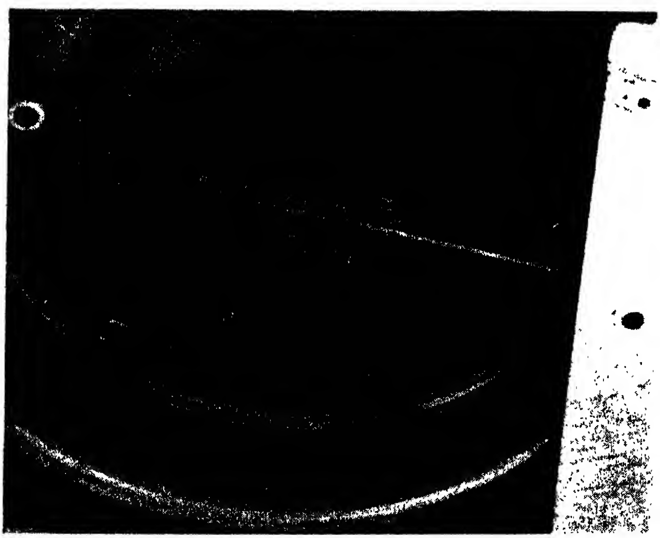

Fig. 6. The method of attachment of rear lifter to the outside pivot on the back wheel.

Fig. 7. Attachment of inside pivot bearing of rear lifter to axle housing.

when the lifters are not in use. The inside attachment for the rear lifter is shown by Fig. 7 and consists of a split-oak pillow-block, loosely fitted to the axle housing.

The framework is covered by 18-gage galvanized sheet iron, and a heavier metal tip protects the sheet metal from damage at the point

As illustrated in Figs. 2 and 3 small 6-inch, flat-rim wheels are used to carry part of the weight of the lifter when in operating position. These wheels also function as gage wheels to compensate for irregularities in the ground surface. However, it is believed that an adjustable shoe could be satisfactorily substituted for these wheels thus simplifying the construction.

The lifters are manually raised and lowered by chains attached to the lifter frame. A lever assembly could easily be built for this purpose. These lifters can be quickly attached and dismounted and have been found satisfactory on muck soils for several crops including onions and potatoes (Figs. 8 and 9).

In dusting or spraying crops, such as potatoes, that produce rank vine growth, injury to the crop from these operations will be materially reduced if the vines are trained by performing each subsequent operation in the same direction of the row.

Fig. 8. Dusting onions.

Fig. 9. Dusting potatoes.

TESTS OF REPELLENTS FOR PROTECTING GARDENS AGAINST COTTONTAIL RABBITS

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COTTONTAIL RABBITS[1] can be an annoying pest in home gardens. Damage consists of the rabbits eating various young vegetable plants, especially peas, beets, green beans, and edible soybeans. Certain annuals and perennials of flower gardens are also consumed. In small gardens the entire crop may be taken, but as gardens cover larger areas, the damage becomes less severe, compared with the total crop. In commercial vegetable plantings the problem seems to disappear. Probably about the same number of rabbits feed in a large garden as would attack a small garden in the same location, since the numbers of these animals seem to be determined by many complex local factors.

Gardens may be protected by fencing with poultry netting 12 or 18 inches high. Rabbits do not seem to pass such fences in search of food, even though they would be able to jump such a barrier with ease. It is not necessary to bury the lower edge of a fence, providing that no openings are left at the bottom. Small stakes, fastened at frequent intervals to the lower wire, are useful in drawing it down to the ground level.

Reduction of the local population by live-trapping or by shooting is often suggested as a method of reducing damage. Cottontails do not enter traps readily during warm weather, and while they may be captured by using many traps, such a procedure is not practical for a gardener. As Pirnie (7) has shown, heavy hunting during the open season may not markedly reduce local numbers during the spring and summer. Further, cottontail damage to gardens frequently occurs in undeveloped suburban areas where city ordinances may forbid shooting.

[1]*Sylvilagus floridanus mearnsii* (Allen).

ARTICLE 31-53

Repellents offer another method of reducing damage to gardens. The purpose of a repellent is to make the protected plant less desirable to rabbits. Rabbits eat a diet composed of a very large number of different plants (4, 5). Certain plants are much preferred to others, and unfortunately this preferred list includes vegetables and flowers which we also prize. A good repellent will remove these plants from the rabbits' list of preferences but not interfere with our own use of the same plants. Then, rabbits may gather their food from the wild plants, without disturbing the garden, for garden vegetables seem to make up only a minute proportion of the normal diet of cottontails. There are a few recommendations in print concerning repellents for use in gardens (1, 2, 6).

PEN AND FIELD EXPERIMENTS

The present paper is a report on tests of repellents carried out from 1941 through 1943, and again in 1946. All tests relate only to cottontail rabbits. Five pen tests, involving 26 rabbits, were carried out, with one test in 1941, one in 1942, two in 1943, and one in 1946. Usable data were also obtained in six field tests. Of the 10 additional field trials where no usable data were obtained, 7 failed as experiments because all damage by rabbits ceased after the treatments were applied, and not even the untreated plants were eaten by rabbits during the experiment.

Tests of effectiveness of repellents are of two kinds, those carried out in pens with confined rabbits, and field tests carried out under natural conditions. Each kind of test has its own advantages (3). Pen tests seem necessary in order to have nearly uniform experimental conditions, and to make tests severe enough to force animals to distinguish between repellents. Field trials, however, must be the final test of whether a repellent is effective and practical.

The pen tests referred to here were carried out by raising string bean or cabbage plants in flats or in tin cans, and then placing these plants, treated, in outdoor pens with the rabbits. In most pen tests, several separately caged rabbits were tested at the same time, in order to study individual differences in preference.

Field tests were carried out either by planting a number of small plots of string beans or soybeans especially for the trial, or by treating vegetable plants already growing in gardens where damage was taking

place. In either type of experiment, a record was kept of the numbers of plants consumed during the following days.

As an example of the difference between pen tests and those in the field, the results observed following use of moth balls (naphthalene) may be cited. In a field experiment at the Kellogg Station near Augusta, Michigan, in September 1946, edible soybeans had been planted in 49 small plots. Owing to various accidents, including drought and insect attacks, only 49 plants with 129 leaves, growing on 21 plots, were usable. These plots were divided into four groups, and the plants treated with three materials: a spray of nicotine bentonite, a dust of tobacco dust and flour, and moth balls, 5 per plot. The plants of the fourth group were left untreated. Over a period of almost 2 weeks, the 33 leaves on the 6 untreated plots were reduced to 8 leaves, presumably by rabbits. At the same time, the 22 leaves of the 5 plots with moth balls were reduced only to 20 leaves. The plots with the other two repellents, considered together, lost 5 leaves out of 74. It would seem that moth balls furnished adequate protection in this test.

In contrast to this observation, data from another field test and from a pen test indicate that moth balls were barely to be distinguished

Fig. 1. Flats of treated string beans and cabbage plants were placed in outdoor pens containing rabbits.

from no treatment at all. It seems, therefore, that in the first field experiment the test conditions were so mild that the minor effect of the moth balls was sufficient to protect the plants. Where rabbits required more effective discouragement, moth balls were of little use. The same minor protective quality may probably be expected of most of the materials which are listed here as of little or no effectiveness.

DIFFERENCES BETWEEN RABBITS

Individual differences among rabbits in their dietary preferences are probably important as one of the reasons for conflicting reports from use of repellents (3). That such differences among individuals do exist was apparent in certain of the pen tests of this study, and the problem has been further investigated in relation to the tree-bark diet of rabbits in winter. Unpublished data of this last study reveal not only individual differences, but also differences between rabbits of one area and those of another. It is not known just how important these geographical variations in food preference may be, but their existence makes impossible any universal recommendation of repellents on the basis of local tests.

In support of the possible usefulness of the materials which are listed below as most effective, is the fact that the greatest individual differences in preference seem to occur in tests of repellents of only moderate protective ability. Further, materials listed in Group I have seemed superior in several pen tests and in field tests at three localities in Michigan (East Lansing, Ann Arbor, and Augusta).

MIXTURES TESTED

The various materials tested are classified here into three groups, according to the relative protective ability observed in the tests. The lists in the present paper are not equivalent to those lists which were published in a former paper (3), relating to repellents useful in protecting trees in winter. The two types of repellents present different problems, and the materials used cannot be compared directly.

In the following lists of materials, the figures following the ingredients show the proportional parts used, by weight, except where some unit of volume is specified. Teaspoon and tablespoon measurements are all level. When a test material was to be applied as a dust, the plants were sprayed lightly with water before dusting.

Several commercial preparations have been tested and are listed according to the results observed. In justice it must be pointed out that none of the manufacturers of these materials recommend their products as rabbit repellents. Inclusion of a brand name does not constitute an endorsement of that product.

GROUP I

The following materials have proven the most effective of those tested, and have shown good protective ability both in pen tests and in field trials. No deleterious effects have been noted following use of these materials with green beans, although no tests of this question have been made.

Nicotine sulfate, 40 percent, ½ teaspoon, water 1 quart, used as a spray. (Black Leaf 40, of Tobacco Biproducts and Chemical Corp., Louisville, Ky.)
Nicotine bentonite, 2 teaspoons, water 1 quart, used as a spray. (Black Leaf 155, of Tobacco Biproducts and Chemical Corp., Louisville, Ky.)
Tobacco Dust. Used as a dust, it is equal in effectiveness to the two nicotine preparations when freshly applied, and superior to anything else after an exposure of several days. Addition of 5 percent flour is said to hold tobacco dust on plants better, but one test indicates that this may slightly reduce the effectiveness against rabbits. Plants should be sprayed lightly with water before dusting.

Red pepper 1, wheat flour 1, used as a dust. Use of a lesser proportion of red pepper, or substitution of black pepper, decreases the effectiveness.

GROUP II

The materials listed in this group have proven in the tests to be less effective than those of Group I, but still clearly provided better protection than did no treatment.

Bordeaux spray: copper sulfate 1 ounce, hydrated lime 1½ ounces, water 1 gallon. In pen tests this ranked in effectiveness with Group I when fresh, but seemed to lose effectiveness after a few days. Some instances of damage to plant tissue may have been caused by this spray.
Bordeaux dust. In pen tests this dust was equal in protective ability to bordeaux spray, and no observations were made concerning the lasting power.

Red pepper 1, wheat flour 5. Used as a dust this was only slightly more effective than flour alone.

Black pepper 1, wheat flour 1, used as a dust.
Wettable sulfur, 10 tablespoons, water 1 quart, applied as a very heavy coating. A lighter coating was less effective.

Rosin dust, consisting of powdered rosin, stayed on the plants poorly.
Rosin emulsion, 2 tablespoons, water 1 quart, used as a spray (from Dr. E. J. Miller, Experiment Station Chemist, Michigan State College).
Flour. Ordinary wheat flour, used as a dust, seems to fall at the lower level of this group.

GROUP III

The protection furnished by these materials was little or no better than no treatment. A few seemed effective in field tests, but not effective in pen tests.

Alum, 2 tablespoons, wheat flour 1 quart, used as a dust.
Lead arsenate, 2¼ teaspoons, water 1 quart, used as a spray. Severe burning of plant foliage resulted from its use.
Gypsum, powdered, used as a dust.
Lime, hydrated, used as a dust.
Lime, hydrated, 2½ tablespoons, water 1 quart, used as a spray.
Sulfur, powdered, used as a dust.
Wettable sulfur, 1½ tablespoons, water 1 quart, used as a spray.
Naphthalene "moth balls," placed on the ground under plants or set in the midst of the leaves on the ends of wires.
Epsom salts, 3 ounces, water 1 gallon, used as a spray.
Lysol, 1 teaspoon, water 1 gallon, used as a spray. (Lehn and Fink Products Co., Bloomfield, N. J.)
Evergreen Spray, 1 teaspoon, water 1 quart, used as a spray. (McLaughlin, Gormley King Co., Minneapolis, Minn.)
Cuprous oxide, ⅓ teaspoon, water 1 quart, used as a spray. (Cuprocide, of Rohm and Haas Co., Inc., Philadelphia, Pa.)
Scram Dog Repellent, 1½ tablespoons, water 1 quart, used as a spray. (California Spray-Chemical Corp., Richmond, Calif.)
A fixed copper, 1 tablespoon, water 1 quart, used as a spray. (Cupro-K, of Rohm and Haas Co., Inc., Philadelphia, Pa.)

SUMMARY

The comparative ability to protect gardens from cottontail rabbits, *Sylvilagus floridanus mearnsii,* is reported for 26 materials as observed in pen and field trials. Highest ranking in protective ability are preparations of nicotine, tobacco dust, and a mixture of red pepper and flour, with tobacco dust showing superior lasting qualities. All of these materials are subject to being washed off in a rain.

Any recommendation of a repellent must be made subject to local field testing, because of probable geographical differences in certain food preferences of cottontail rabbits.

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A MODIFIED ASSOCIATION—BABCOCK TEST FOR HOMOGENIZED MILK

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DIFFICULTY ENCOUNTERED in testing homogenized milk by the standard Babcock procedure has stimulated the introduction of numerous modifications of the method. Trout and Lucas (1945), comparing 12 modifications of the Babcock method for testing homogenized milk, reported that most satisfactory tests were obtained when the full amount of normal-strength sulfuric acid was introduced in at least three portions, was centrifuged, and then shaken following the addition of water.

From these studies, Lucas and Trout (1947) introduced another modification of the Babcock test, the technique of which involved a) tempering the acid and milk to 70°F.; b) using at least 17.5 ml. of sulfuric acid with sp. gr. of 1.83 to 1.835; c) adding the acid in three portions, the first consisting of approximately one-half of the acid; and d) prolonging the agitation of the acid-milk mixture prior to centrifuging. While this method yielded results on homogenized milk only 0.018 percent lower than that of nonhomogenized milk, routine laboratory use of the method showed that its success depended to a large extent upon the technique and experience of the operator.

To determine the applicability of selected methods for testing homogenized milk, Trout and Lucas (1947) made a comparative study of the Gerber, Minnesota, Pennsylvania, and Mojonnier methods. They reported satisfactory tests of homogenized milk by the Mojonnier and Gerber methods. However, for routine testing of milk the Mojonnier procedure is not so desirable as tests utilizing Babcock glassware. The Gerber method was found to be quite satisfactory for testing homogenized milk. The chief limitation to the use of the Gerber method in this country would be the necessity of introducing a completely new testing procedure requiring special testing equipment and training into the industry, as well as the long procedure of securing the

ARTICLE 31-54

recognition of the test as a legal method by the several state and national legislatures.

Consequently, it was felt that a rapid test utilizing the present Babcock testing equipment but depending to a lesser degree on the personal factor would be desirable. To this end further studies were made.

EXPERIMENTAL

Samples of pasteurized milk homogenized at 2500 pounds pressure and held at 40°F. for 12 hours were tested by various methods. Procedure, simplicity, appearance of the fat column, and accuracy of the test as compared with Mojonnier determinations were factors considered. A modification of the Association (1933) test for buttermilk produced encouraging results. This procedure, in addition to utilizing the standard Babcock testing equipment found in every milk plant, requires but one reagent other than the normal-strength, commercial sulphuric acid. The second reagent, normal butyl alcohol, may be obtained from most dairy or chemical supply houses.

Method—The testing procedure as finally adopted was as follows:

a. Temper the sample of homogenized milk to be tested and the sulfuric acid to 60°F.

b. Pipette 17.5 ml. (18 grams) of the tempered sample into an eight-percent milk test bottle. Add 3 ml. of normal butyl alcohol and 14 to 16 ml. of acid. Shake for approximately one minute.

c. Centrifuge test and add water as in standard Babcock procedure.

d. Add two or three drops of glymol to the top of the fat column just prior to reading the test. With the aid of dividers, read from the glymol-fat interface to the base of the lower meniscus.

The procedure as outlined requires no special precautions or manipulations other than those generally observed in the standard Babcock procedure. Ten samples of homogenized milk were tested in triplicate by the above-mentioned procedure, and the averages of these tests were compared with averaged duplicate Mojonnier determinations (Table I).

TABLE 1—*Comparison of modified Association-Babcock and Mojonnier tests of homogenized milk*

Sample number	Modified Association-Babcock test				Mojonnier test (average of duplicates)	Deviation from Mojonnier test
	Trial 1	Trial 2	Trial 3	Average		
	Percent	Percent	Percent	Percent	Percent	Percent
1	3.30	3.40	3.30	3.33	3.3105	+.0195
2	3.60	3.60	3.60	3.60	3.5940	+.0056
3	3.60	3.60	3.70	3.63	3.6705	−.0405
4	3.60	3.50	3.60	3.57	3.5789	−.0089
5	3.90	3.90	3.90	3.90	3.8921	+.0079
6	4.00	4.00	4.00	4.00	4.0111	−.0110
7	4.10	4.00	4.00	4.03	4.0130	+.0170
8	4.10	4.10	4.10	4.10	4.0820	+.0178
9	4.00	4.00	4.10	4.10	3.9500	+.0500
10	5.40	5.50	5.40	5.43	5.4202	+.0098
					Average deviation......	+.0089

DISCUSSION

While too little acid or too low sample temperatures result in the appearance of nondigested curd formation at the base of the fat column, too much acid or excessively high sample temperatures cause charring and the appearance of charred particles throughout the fat column. Although these characteristic defects were sometimes obtained they did not represent a serious problem if ordinary precautions were observed. In fact, it was quite difficult to produce these defects experimentally. Nevertheless, some variation in operational temperatures may be tolerated without appreciably affecting the reliability of the test.

Consistently clear fat columns, free from curdy deposits or charred material, were obtained when 15 ml. of acid at room temperature was added to milk samples at 50° to 55°F. Equally satisfactory tests were obtained by adding 14 to 16 ml. of acid at 60°F. to milk samples tempered to the same temperature.

During the course of experimentation it was observed that the use of less than 2 ml. of normal butyl alcohol was conducive to the formation of a curdy layer at the base of the fat column. When this defect occurred, the fat determination was generally below that obtained by the Mojonnier method. The curd layer was not eliminated by the use of larger quantities of acid, which had in effect a greater tendency to burn the sample, but by the use of more butyl alcohol in making the test.

On the other hand, if normal butyl alcohol in excess of a 3-ml. portion were added these defects were minimized, but the results were

about one-tenth percent higher than those by the Mojonnier method. The optimum quantity of normal butyl alcohol required to produce consistently clear, accurate fat columns with 14 to 16 ml. of acid at 60°F. was 3 ml.

The addition of glymol prior to the reading of the fat columns seems to be an integral part of the test proposed in this study. Otherwise, the test would yield results from 0.10 to 0.15 percent higher than those obtained by the Mojonnier method.

SUMMARY

The Association test, modified for testing homogenized milk, has been used effectively. The modified Association test consists in a) tempering the milk and reagents to 60°F.; b) adding 3 ml. of normal butyl alcohol and 14 to 16 ml. of commercial sulfuric acid to 17.5 ml. of milk; and c) using glymol in reading the fat columns. The results obtained by this procedure on ten samples of homogenized milk were clear, free of curdy material at the base of the fat column, and averaged within ±0.05 percent of the results obtained by the Mojonnier method, the average deviation being +0.009 percent.

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CONSUMER REACTION TO BOTTLED FRESH CONCENTRATED MILK

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CONSIDERABLE PUBLICITY has been given lately to methods of processing and distributing milk, which might mislead the consumer to believe that immediate changes in the present system of assembling, processing, bottling and distributing fresh milk are in the offing (1).

One of these methods developed in Indiana by Stambaugh and Graves consisted, in brief, in homogenizing the warm milk as it was assembled in a vat directly from the cows, pasteurizing the milk at 190° F. for 1 second in a jacketed, steam cylinder, fitted with a spiral core, canning and sealing it in a nitrogen atmosphere and, lastly, sterilizing the milk. Another method first introduced by Meredith and Stoltz (2) of Ohio and recently studied in Michigan consisted in concentrating the milk under vacuum, homogenizing, pasteurizing, cooling, bottling, and distributing it the same as is done with regular milk.

The Indiana method involves processing the milk directly from the cow to the can. The product is not concentrated; hence, the product remains as normal milk in composition. On the other hand, the Ohio method involves vaporizing off much of the water under vacuum, thus reducing the bulk for more economical distribution. The milk may be reconstituted in the home for beverage purposes merely by the addition of water. A brief review of the Ohio process and its acceptance by the consumer is of interest.

During the depression years of the early 'thirties Meredith and Stoltz (2) introduced bottled concentrated milk in order to make available a lower priced fresh milk for the consumer. Observations on consumer reaction to the reconstituted product, as well as numerous studies on the effects of the process on various properties of the milk, indicated that the product had much merit. Nevertheless, the product never "caught on". This may have been due in large part to the fact

ARTICLE 31-55

that the product was ahead of its time. Since then, some changes have been made in milk distribution which might make a bottled, concentrated milk more acceptable. For example, every-other-day delivery has crowded the consumers' refrigerator despite the advent of the square bottle. Also, store sales in some metropolitan areas have far exceeded home delivery sales (3). A bottled concentrated product would require less refrigerator space, and less weight would be involved in carrying home concentrated milk from the stores. Already paper containers have reduced somewhat the weight of the milk load carried from the stores.

In view of these trends and the fact that normal milk is bulky because of its high water content, thus adding to the processing and distributing costs, it seemed desirable to make further studies on consumer reaction to bottled fresh concentrated milk. This paper is a progress report on the data obtained to date.

PROCEDURE

Fresh whole milk previously heated to 150° to 160° F., was concentrated in a 42-inch stainless steel vacuum pan at ratios of 2:1, 3:1, and 4:1. Following concentration the milk was holder-pasteurized, homogenized at various pressures, cooled and bottled. Quiescent-storage, fat-rising tests were made at 48 hours to ascertain the efficiency of homogenization. Flavor examinations were made in the laboratory on the reconstituted product, using for reconstitution waters obtained from three widely separated sections of Michigan. Consumer reaction was obtained through questionnaires to consumers who were furnished samples of the series under study.

RESULTS

EFFECT OF CONCENTRATING AND RECONSTITUTING ON THE FLAVOR OF THE MILK

Milk concentrated at various ratios and reconstituted to its original composition was judged by experienced milk judges as well as by consumers. The judgments of the experienced judges are recorded in Tables 1 and 2; those of consumers are presented in another section. In some of the trials the experienced milk judge was inclined to criticize the flavor of the concentrated-reconstituted milk. When "excellent" flavor milk was so processed the judges placed the concentrated milk, so far as flavor was concerned, in the class of "good" or "fair"

milk. As the ratio of concentration increased, which necessitated greater additions of water to restore it to its original composition, the flavor was less desirable. However, the flavor of the reconstituted milk was not objectionable although generally the judges criticized it as "flat" or "cooked", the fine, excellent flavor having been impaired in the process. This flavor criticism was not greater than sometimes is experienced with commercially pasteurized milk.

TABLE 1—*Flavor of milk concentrated at various ratios and reconstituted to its original composition by the addition of water*

Homogenization pressure (lbs./sq. in.)	Flavor score* of the			
	Original milk	Reconstituted milk which had been concentrated at the ratio of		
		2:1	3:1	4:1
0	23	21½	20½	19
2500	23	21½	20½	19
4000	23	21½	20½	18½

*Key: 23, excellent; no criticism
21–23, good
18–21, fair

TABLE 2—*Effect upon the flavor when concentrated milk was reconstituted with water obtained from widely separated areas of Michigan*

Homogenization pressure (Lb./sq. in.)	Ratio of concentration	The flavor of the reconstituted-concentrated milk which was reconstituted by the addition of water from area		
		A	B	C
0	None			
2500	None			
4000	None			
0	2:1	No criticism	No criticism	Salty
2500	2:1	Sl. cooked	No criticism	Sl. salty
4000	2:1	No criticism	No criticism	Sl. salty
0	3:1	No criticism	No criticism	Salty
2500	3:1	No criticism	No criticism	Salty
4000	3:1	Watery	No criticism	Salty

The source of the water used in reconstituting the milk has some effect on the flavor of the reconstituted product (Table 2). When drinking water from one area, designated as area C, was used in reconstituting the milk, the flavor of the milk was invariably criticized as being salty. The original water also tasted of salt, however. No off flavors were noted in the reconstituted milk when water from other areas was used.

THE ROLE OF HOMOGENIZATION IN PROCESSING CONCENTRATED MILK INTENDED FOR BOTTLING AND RECONSTITUTING

The effects of concentration and homogenization upon fat rising in the reconstituted milk are shown in Table 3. As the ratio of concentration increases, the extent of fat rising decreases as indicated by the percentage difference of fat between the upper 100 ml. and the remainder of a quart after 48 hours of quiescent storage. This might well be expected since higher concentrations require longer exposures to the heat and agitation incident to the process. Nevertheless, sufficient fat rises in the reconstituted milk regardless of the ratio of concentration to yield a creamy concentration on the surface. The creaming ability of the milk is so impaired, however, by the process that normal creaming does not occur. Hence, adequate homogenization would seem to be essential in producing concentrated milk for bottling purposes. Data indicate that pressures of 2,000 to 2,500 pounds per square inch would seem to be adequate. The data reported in Table 3 were obtained on milk homogenized prior to condensation. Data obtained on other trials in which the milk was homogenized after concentration indicate that pressures of 2,000 to 3,000 pounds were sufficient to keep the percentage difference in fat between the upper and lower portions to 5 percent or below.

TABLE 3—*Influence of concentration upon the extent of fat rising in the reconstituted milk*

Homogenization pressure (Lb./sq. in.)	Percentage difference of fat between the upper 100 ml. and the remainder of a quart of the reconstituted milk after 48 hours of quiescent storage when the ratio of concentration was			
	None	2:1	3:1	4:1
	percent	percent	percent	percent
0	239.72	84.57	60.27	43.62
2500	7.75	−0.24	4.40	1.80
4000	2.5	−2.92	7.8	0.79

TECHNICAL PROBLEMS IN PROCESSING AND BOTTLING CONCENTRATED MILK

The technique of producing concentrated milk for bottling is essentially the same as that for evaporated milk. Both involve vacuum condensation and adequate homogenization. However, since the bottled product is not sterilized, those techniques to prevent curdling of milk under pressure sterilization of evaporated milk are not a part of the processing of concentrated milk for bottling purposes. The forewarming temperature is purposely kept low, between 150° and 160° F., in

order to prevent so far as possible a cooked flavor. Nevertheless, in our present method of condensing even under high vacuum, steam at low pressure is used as the heating medium. The temperatures of the steam vary with the pressure and are always above 212°F. Such temperatures applied to microscopic films of milk repeatedly during the process inevitably cause a heated, "condensed-milk" taste despite the low indicating thermometer temperature (135° to 140°F.) of the milk itself during evaporation. Thus, under this system of evaporation, the fresh, nonsterilized milk will have the cooked flavor, more or less pronounced.

With experience, concentrating the milk to a predetermined ratio and desired composition may be done within limits. However, exact composition is attained by final testing and standardization after the concentrate is drawn from the pan. Homogenization, pasteurization, cooling and packaging then follow.

Securing low bacteria counts and negative phosphatase tests presented no difficulties. Standard plate counts of the concentrated product ranged from 500 to 13,000. Phosphatase tests were all negative. Nevertheless, coliform tests indicated post-pasteurization contamination. This is not surprising considering the small quantity of each batch, about 25 gallons, actually packaged, which involved manual operation, in part.

CONSUMER REACTION TO THE FLAVOR OF FRESH CONCENTRATED MILK

Bottles of milk concentrated at the ratio of 2:1 and 3:1 were furnished many families and individuals, along with a questionnaire asking for certain specific information. Specific directions on reconstituting the milk were given. The following questions concerning flavor were asked:

a) *Do you see any difference in the taste of the reconstituted milk as compared with that of the milk you have been using?*

A total of 123 questionnaires were returned; 31, 50 and 42 being received from trials 1, 2 and 3 respectively. Not all responding to the questionnaire answered all the questions asked. The percentage distribution of the responses are presented in Table 4. These were recorded as three trials. Trial 1 represents a composite of responses on three different lots of milk. Samples from these lots were furnished to older individuals and families wherein the feeding of chil-

dren likely did not aid in the detection of differences between the reconstituted-concentrated milk and the regular milk. Responses in trials 2 and 3 were from two individual lots of milk. "GI" families and younger people, as well as many older people, were furnished samples. Data indicate that an overwhelming majority of those using the milk could detect differences between the reconstituted-concentrated milk and the regular milk (Table 4). However, this high percentage of detection of flavor difference does not infer that the flavor noted was objectionable in any way. In fact, data indicate that the flavor was not objectionable although a difference in flavor was noted (Table 4).

TABLE 4—*Consumer response concerning possible flavor differences between reconstituted-concentrated milk and regular pasteurized milk*

Response as to flavor	Percentage distribution of responses in		
	Trial 1	Trial 2	Trial 3
	percent	percent	percent
Difference in flavor			
Yes	69	82	90
No	31	18	10
Flavor objectionable			
Yes	19	22	23
No	81	78	64*

*13 percent made no response.

b) *Was the flavor objectionable?*

Those noting differences between the flavor of the reconstituted-concentrated milk and regular milk were asked to describe the flavor of the reconstituted product. The following responses were given:

Seemed somewhat heavier than normal milk.
Tastes more like condensed milk.
Possibility of taste from water used to dilute.
A lingering taste of condensed milk, not serious.
Slight cooked.
Some different flavor as if cooked.
Sweeter.
Sweeter, like caramel, smoother.
Little more bland and slightly sweeter.
Tastes boiled.
Sweeter and smoother.
Like regular homogenized milk.
Richer, definitely sweeter.
Too creamy, tastes like milk made from dry powdered milk.
Cooked, salty.
Salty; far superior to our regular milk.
Rich, smooth.

Some evidence of cooked flavor.
Tastes like raw milk.
A sickening, heavy sweet taste. Also cooked.
Cooked.
Slightly thicker and rich flavor; seems sweeter.
Cooked, abnormally sweet.
Seems richer and slightly sweeter—like ice cream.
Creamy and a little richer; a slightly cooked flavor.
Only slightly cooked.
Slight sweet taste not apparent in raw milk.
Suggestion of condensed milk taste.
Slightly cooked but rather pleasing.
Dairy products flavor.
Caramel taste.
Chalky taste.
Tastes like evaporated milk.
Slightly burned taste.
Similar to cow's milk, like Jersey, maybe richer.
Slightly sweeter than ordinary milk.
Seems to have slightly condensed flavor.
Too rich tasting after one glass.
Soap taste.
Slight taste of being scalded.
A bland flavor.
A more distinct taste but not like evaporated milk.
A chalky taste.

A survey of this list of descriptions shows that the flavors associated with the heat of processing such as "cooked," "condensed," "boiled," "caramel," seem to predominate. Flavor terms such as "sweeter," and "richer," appear to follow closely.

CONSUMER PREFERENCE OF CONCENTRATION

In these studies the milk was concentrated 2:1, 3:1 and 4:1. The latter concentration was so viscous and involved the addition of so much water in reconstituting it to its original composition that further studies on it were discontinued. Thus, only concentrations of 2:1 and 3:1 were submitted for consumer reaction. Data did not seem to indicate any decided preference over one for the other; in trial 1 responses were tied; in trial 2 the concentration of 2:1 was preferred, whereas in trial 3 the 3:1 concentration was the choice. Considering the increased viscosity, adhesion to container, and amount of water to reconstitute it, the 3:1 concentration would seem to be too concentrated. However, approximately two-thirds of those responding to the questionnaire found no difficulty in reconstituting the milk, but did not specify which concentration.

Saving of refrigerator space—Since the product is concentrated less refrigerator space would be required than for storing an equivalent amount of regular milk. It seemed desirable to ascertain if the saving of refrigerator space would be of any value to the consumer. Obviously, it was. Responses in trials 2 and 3 (the question was not asked in trial 1) showed that 61.2 and 76.7 percent, respectively, considered the saving of refrigerator space valuable to them. A small percentage made no reply to this question.

CONSUMER REACTION TO POSSIBLE PURCHASE OF BOTTLED CONCENTRATED MILK IF IT WERE MADE AVAILABLE

Those having the opportunity of using the milk were asked if they felt honestly they would be interested in using it if it were made available. Responses indicated they would be interested in using the product, only if there were a saving of 3 cents per quart of milk equivalent (Table 5). A small percentage indicated they would not buy the product at all. Eighty-six and 87 percent, respectively, of those responding in Trials 2 and 3 to the question *"In your opinion has this milk any commercial possibilities?"* indicated they believed bottled concentrated

TABLE 5—*Reaction of the consumers who used fresh concentrated bottled milk towards buying it if it were made available*

Response	Percentage distribution of responses in		
	Trial 1	Trial 2	Trial 3
Interested in using the product			
Yes	—	66	82
No	—	28	18
Questionable	—	6	0
At the same price as milk equivalent?			
Yes	26	12	22
No	74	—	—
At the saving of 2 cents per quart of milk equivalent?			
Yes	52	24	25
No	48	—	—
At the saving of 3 cents per quart of milk equivalent?			
Yes	67	40*	53
No	33	—	—

*6 percent would not buy at all; 15 percent made no response.

milk had commercial possibilities (Data not included in Table 5). The remaining made no reply to the question. Yet, those indicating the product had commercial possibilities manifested, as shown by percentage distribution figures (Table 5) that a material saving per quart of whole milk equivalent had to be effected.

DISCUSSION

Bulk, and hence weight, has always been a factor in the economic distribution of milk. Nevertheless, dependable doorstep delivery of safe milk of good beverage quality has done much toward increasing and maintaining high levels of fresh milk consumption in the United States. That the percentage distribution of home-delivered milk will decrease and retail store sales will increase in metropolitan areas is inevitable. Already in some markets such shifts in distribution methods have occurred at a profound rate. Single-service containers, having less weight, have been a factor in the shift to store sales. Just what influence such packaged fresh concentrated milk would have on store sales and maintained milk consumption is highly speculative. The data reported herein furnish some evidence that, at a price, concentrated milk might be purchased and that although there may be a slight cooked flavor, the reconstituted milk had good beverage quality. Indications were noted also that the product might well be used without reconstitution in soups and as cream in coffee or on cereal.

While the product itself does have much merit it is not unthinkable that its introduction could be associated with embarrassing situations to the dairy industry. For instance, the health hazard of reconstituting milk in the home is not to be overlooked. Even sickness, traceable to milk, would have a depressing effect on milk consumption. The attitude of the health and regulatory officials must be considered also. Health regulations in many cities do not permit double pasteurization of milk. While the condensing process is not a pasteurization process it does involve a comparatively high heat treatment which may be construed as one form of pasteurization although not recognized as such. Actual pasteurization must follow the condensing, standardizing and homogenizing processes to assure a safe product. Furthermore, the psychological aspect of diluting milk with water is not conducive to the anticipation of milk drinking. It is believed that one of the factors responsible for the high level of milk consumption in the United States is the making available at all times by home delivery or through stores packaged, fresh, safe milk at a fair price.

Data obtained in the Ohio studies in 1935 show the cost of quantity concentration to be materially less than one cent per quart of whole milk equivalent. Thus the cost of concentration is not prohibitive. Savings on items such as container cost, especially if paper containers were used, closures, bottle washing and delivery might be effected. Nevertheless processing, packaging, and distribution of fresh concentrated milk does not lend itself to economies to the extent that prevail in the evaporated milk industry. It is believed, however, that some opportunities do exist for a reduction in the retail price of milk through concentration, provided there is sufficient volume to permit efficient use of evaporating equipment. Thus, while the introduction of fresh concentrated milk might make available to the consumer lower priced milk than that of standard bottled milk it remains to be seen if the reduction in price would be sufficient to stimulate increases in milk consumption. On the other hand, fresh concentrated milk produced in surplus areas for transportation and use in territories experiencing a shortage of milk would seem to offer great possibilities. Such milk thus might be a) bottled and distributed as a concentrate, b) reconstituted and bottled, and or c) reconstituted and mixed with the existing milk supply as an extender.

SUMMARY

Bottled fresh concentrated milk, concentrated at ratios of 2:1 and 3:1, homogenized and pasteurized, was furnished consumers in order to find out their reactions to the product.

The process of concentration itself was very similar to that employed in preparing evaporated milk for canning. Insofar as possible low temperatures in forewarming were used to keep the formation of heated flavors to a minimum. Nevertheless, the cooked type of flavor seemed to predominate in the reconstituted product.

Homogenization pressures of 2,000 to 2,500 pounds per square inch were adequate to maintain satisfactory homogeneity of the reconstituted product.

Little difficulty seemed to be encountered in reconstituting the product in the home. The type of water used was found to be a factor affecting the flavor of the reconstituted milk but was believed not to be a serious one.

As a rule, consumers noted a difference in flavor between the reconstituted milk and regular pasteurized milk, but the cooked flavor predominating was not objectionable to the majority of the consumers surveyed in the study. While most of the consumers were interested in the added refrigerator space afforded by using the concentrated product they were not interested in buying it regularly unless a saving of 2 or 3 cents per quart of milk equivalent could be effected. However, the greater percentage of consumers believed that bottled, fresh, concentrated milk had commercial possibilities.

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THE ACTION OF ACTIDIONE ON PLANT TISSUE AND UPON CERTAIN FUNGI

By JOHN R. VAUGHN, JOHN L. LOCKWOOD, G. S. RANDWA, and CHARLES HAMNER

SECTIONS OF BOTANY AND PLANT PATHOLOGY AND HORTICULTURE

A PRELIMINARY REPORT on the use of actidione, an antibiotic, for the control of mildew on bean plants has been reported in the *Botanical Gazette* (1). It was found that where an aqueous solution of actidione at 10 p.p.m. was sprayed on bean plants affected by mildew, the grayish white patches on the upper surface of the leaves disappeared completely within 48 hours, indicating that the mycelium and the conidia of the fungus *Erysiphe polygoni* D. C. had been destroyed.

Since mildew is a problem on many plants grown in the greenhouse and in the field, it was decided to investigate the action of actidione on a wide variety of plants to see what possible toxic effect it might have on plant tissue and seeds. The fungal spectrum for other organisms which cause plant disorders was also investigated.

The actidione used in these experiments was obtained from the Upjohn Company, Kalamazoo, Michigan. It is an antibiotic material obtained from the cultures in which streptomycin-producing strains of *Streptomyces griseus* are cultivated (3, 4). The chemical structure has been determined and described (5).

EXPERIMENTAL

Seed germination was tested using peas (var. Shasta), radish (Scarlet Globe), wheat (American Banner) and beans (Red Kidney) as the test materials. The procedure was to soak the seeds in an aqueous solution of actidione for a period of 4 hours, and then plant the seeds in petri dishes in moist filter paper. In the case of radish and wheat, 50 seeds were planted per dish and replicated four times. When peas were used, 25 seeds were placed in each dish and the treatments were replicated four times. For comparison, seeds soaked

ARTICLE 31-56

in tap water for 4 hours were used as controls. The dishes containing the seeds were then placed on laboratory tables at room temperatures which remained constant at about 75° F. In order to determine reaction of the seeds to the treatments, germination records were taken daily.

Because of their large size, bean seeds were placed in soil under greenhouse conditions. In experimentation with actidione on peas, radish, and wheat seed, the seeds were soaked in concentrations of 1, 5, 10, 20, 50 and 100 p.p.m. of actidione.

With certified Red Kidney bean seeds the seeds were soaked in concentrations of actidione at ½, 1, and 10 p.p.m. for 4 hours. They were then planted in soil in flats. Fifty seeds were planted per flat and four flats used in each treatment, making a total of 200 seeds per treatment. The flats were placed on a bench and allowed to germinate under greenhouse conditions.

In addition, seeds of cucumber, cantaloupe, and spinach were soaked in strengths of 1, 5, 10, 20 and 100 p.p.m. of actidione for one-half hour. These were planted in replicated rows in flats and stand counts taken at intervals.

DISCUSSION OF RESULTS ON SEEDS

The same concentration of actidione was used with radish and wheat seed as with peas. The inhibition in germination of radish seeds was much more pronounced than with peas. Almost complete inhibition occurred at 100 p.p.m. while 28 percent occurred at 50 p.p.m. Even though very little decrease in eventual germination occurred either at 1 or 5 p.p.m., there was considerable delay in germination (Fig. 1).

It should be noted that the pea seed during the 4-hour soaking period did not absorb much water and as a result possibly much less actidione was absorbed in comparison to radish, wheat, and bean seeds which took up water freely during the soaking period. The results, however, show considerable inhibition in germination, with actidione only about 38-percent germination being noted at 100 p.p.m. (Fig. 2). In general, the inhibition in germination was in proportion to the concentration of actidione.

A similar inhibition in germination with actidione was noted with wheat seed except that a concentration of either 10 or 20 p.p.m. resulted in almost the same degree of inhibition. It should be noted

that almost complete inhibition of wheat seed germination occurred at 100 p.p.m. indicating that the reaction of wheat seed to actidione was much more pronounced than to a similar concentration of 2,4-D (2) (Fig. 3).

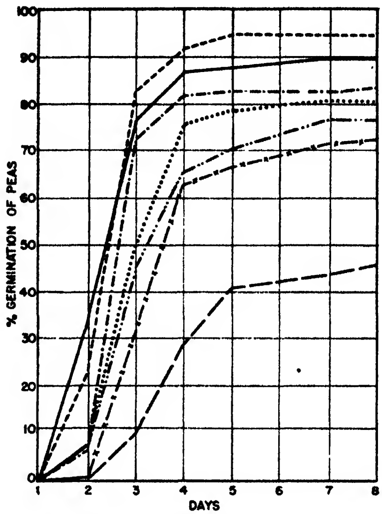
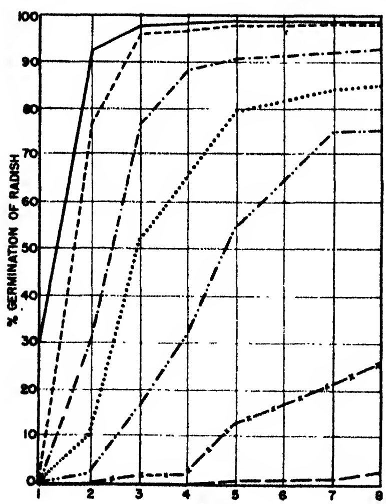
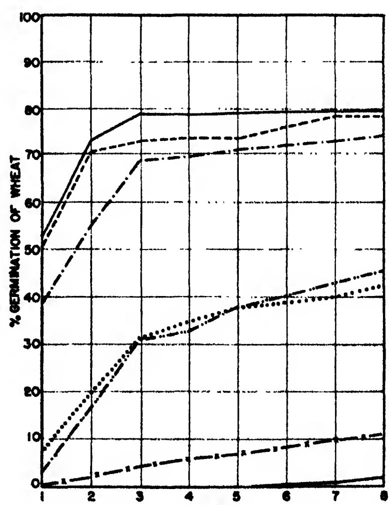


Fig. 1.





——— Control
- - - - 1 Part per Million
-·-·-·- 5 Parts per Million
········ 10 Parts per Million
-··-··- 20 Parts per Million
x—x—x—50 Parts per Million
— — — 100 Parts per Million

Fig. 2. Fig. 3.

Results show that about a 50-percent decrease in germination occurred when pea seeds were soaked in an aqueous solution of actidione at 10 p.p.m. (Fig. 1).

Because of its possible use as a soil fungicide, actidione was applied to the soil at concentrations of 1, 5, and 10 p.p.m. In each treatment 50 Red Kidney bean seeds were planted per flat and replicated four times.

When actidione was applied to the soil at 10 p.p.m., considerable inhibition of germination occurred. The degree of germination of beans in soil treated with 10 p.p.m. of actidione was 17.4 percent as compared to 46.7 for the controls (Fig. 2).

The one-half hour soak of seeds of cantaloupe, spinch, and cucumber gave absolutely no evidence of inhibition of growth or decrease of germination when compared with non-treated controls. Not even the highest concentration used (100 p.p.m.) was different in percentage of germination of seeds or vigor of seedling plants.

TREATMENT OF ROSES

With the application of new insecticides in aerosol form in many commercial greenhouses, it appears that powdery mildew is becoming more of a problem in many plants and its control by chemical methods has not been satisfactory. It has also been reported by many growers that sulfur and parathion are not compatable and, hence, cannot be used together in a spray program. Since parathion will undoubtedly be used by most growers for insect control, it would seem desirable to explore other methods than sulfur for mildew control.

Several trials with actidione on roses were run in commercial greenhouses. The concentrations of actidione used in these tests ranged from 2½ to 10 p.p.m. It was apparent from the early tests that the young succulent leaves were rather severely injured at 5, 7½, and 10 p.p.m. Mildew, however, was very readily controlled at those concentrations. The older, more mature leaves appeared not to be affected. The youngest leaves showed a certain amount of twisting and bending, somewhat similar to that caused by growth regulators. In addition, many of the leaves became chlorotic and some exhibited small pin-point necrotic areas. The injury to the leaves appeared to vary, depending upon variety and environmental conditions. If application

of actidione was followed by sunny days, the extent and intensity of injury were increased.

Experiments were then conducted, using actidione at 2½ p.p.m. It was apparent that mildew could be controlled very satisfactorily at this concentration, but even at 2½ p.p.m. some injury to the new foliage was evident.

TREATMENT OF OTHER PLANTS

A wide variety of greenhouse plants were then treated with actidione at 7½ p.p.m. to see what possible toxic effect it might have on the foliage. It was believed that at 7½ p.p.m., powdery mildew could be easily controlled, the only question being its toxic effect on the plants.

EFFECT OF ACTIDIONE ON GROWTH OF PATHOGENIC FUNGI IN CULTURE

One of the methods used in evaluating fungicidal materials is to grow pathogenic species on a medium which contains a known concentration of the material (2). An experiment was conducted, using 10 pathogenes growing on potato dextrose agar with concentrations of 0, 1, 5, 10, 20, and 100 p.p.m. of actidione. Linear growth of the

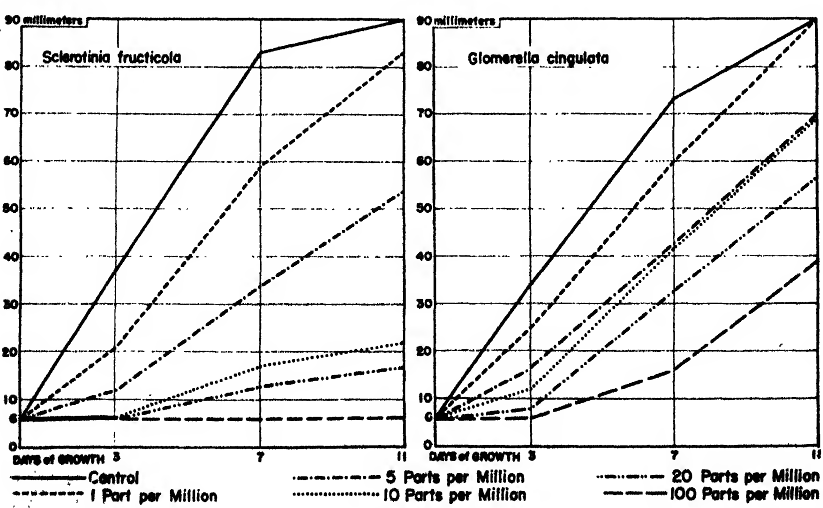


Fig. 4.

colony was measured at intervals and the experiments were run for 11 or 12 days. Each measurement of growth represents the average for four plates. Figures 4 to 8, inclusive, show graphically the results of this experiment.

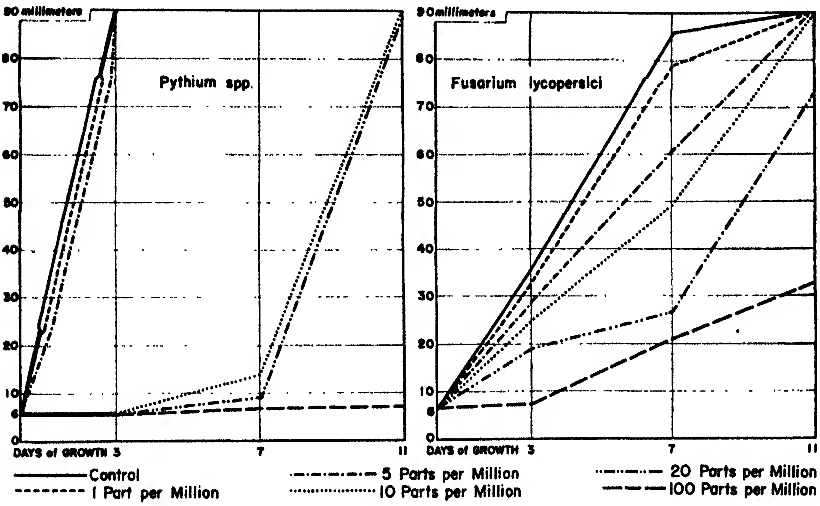


Fig. 5.

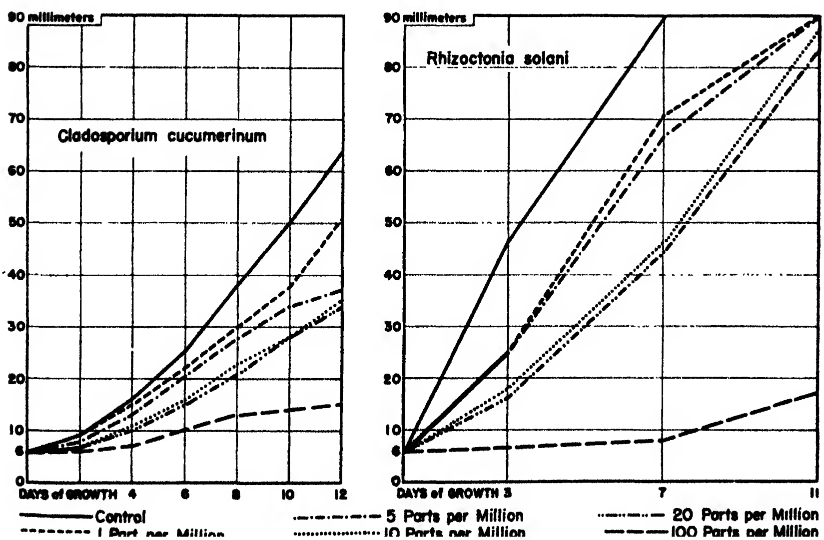


Fig. 6.

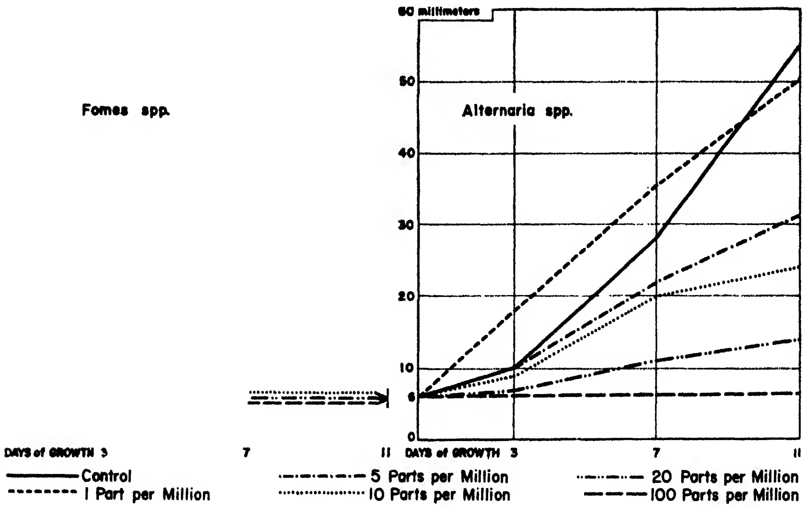


Fig. 7.

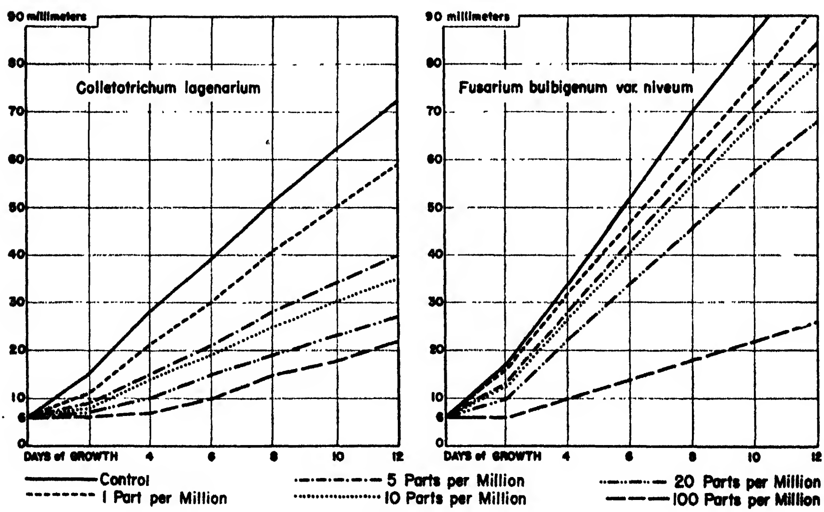


Fig. 8.

All of the fungi were affected by the presence of actidione in the medium, but some were more affected than others and some affected only by the highest concentrations. Among those showing a striking response were *Sclerotinia fructicola*, the cause of brown rot of stone

fruits; *Cladosporium cucumerinum*, cause of scab of cucumbers; *Fomes sp.*, a wood-rotting fungus; *Alternaria sp.*, pathogenic on tomatoes; and *Colletotrichum lagenarium*, cause of cucumber anthracnose. All of the ten species used were inhibited by the 100 p.p.m. concentration and the above-mentioned fungi were inhibited more or less by all of the concentrations.

These results are, of course, preliminary, and laboratory assay is only an indication of use in the field. Field tests will be conducted during the coming season on some of these diseases and laboratory assay is continuing against other pathogenic species. From the laboratory assay, it can be generalized that actidione certainly has fungistatic properties and is worth further testing. The results of tests of phytotoxicity have been variable and the action of the material against fungi is also variable. This is true of several of the newer organic fungicides, and is not a surprising result.

DISCUSSION AND CONCLUSIONS

The new antibiotic material, actidione, controls mildew under greenhouse conditions on beans and roses. On beans there is no sign of toxicity at concentrations of 10 p.p.m. or lower, and control is obtained at 10 p.p.m. On roses there is control of the mildew but the phytotoxicity is much more pronounced. This injury has been observed to vary from variety to variety and with the environmental conditions after spraying. Injury is much less severe on older foliage than on young foliage and control can be obtained on roses by spraying with concentrations of less than 5 p.p.m. Before growers try the material on a large scale, more intensive experiments should be done to clarify the matters of timing of sprays; use of spreaders, stickers, etc.; and the toxicity to various rose varieties.

There is also a variation in the toxic properties of actidione to seeds when they are soaked in various concentrations of the material. Variations in phytotoxic activity is to be expected and extensive tests against many crops are being conducted.

The growth of pathogenic fungi on a culture medium containing actidione indicates strong inhibition of 10 different pathogenes at concentrations of 100 p.p.m. of actidione. Several fungi are markedly inhibited by concentrations as low as 5 p.p.m. Although such a laboratory assay is indicative of a trend only, it can be concluded that the

material is worthy of extensive testing against plant disease fungi, both in the laboratory and in the field.

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A COMPARISON OF SEGMENTED WITH NATURAL SUGAR-BEET SEED

By L. S. ROBERTSON, R. W. BELL, R. L. COOK, *and* H. W. FAIRCHILD
SECTIONS OF SOIL SCIENCE AND FARM CROPS

THERE WAS PUBLISHED in 1945 a report[1] of the results of one year's comparison of segmented (or sheared) sugar-beet seed with natural (or whole) sugar-beet seed. This experiment was continued in 1946 and 1948. The following constitutes a report of the findings covering the three years.

The comparisons of segmented and natural seed were conducted in connection with the Ferden Rotation Experiment. Comparisons were made between the two types of seed on the following bases: seed germination, pre-blocking stand, post-thinning stand, number of marketable beets, acre-yield and labor requirements in thinning.

PROCEDURE

The experiment comprised 56 beet plots, each 14 feet wide by 90 feet long. Each plot contained 6 rows of beets spaced 28 inches apart. All plots received row applications of 2-16-8 fertilizer at planting time, half of them at the rate of 500 pounds per acre, the other half at 200 pounds per acre. A detailed description of the Ferden Rotation Experiment is published elsewhere.[2]

The soil, a Brookston sandy clay loam, was drained by both tile and open ditches. In spite of this, internal soil drainage was slow because of a compact subsoil.

Before planting, each plot was split lengthwise. Half (3 rows) was planted with segmented seed and the other half (3 rows) with natural seed. In each of the three years, natural seed was planted at the rate of 11.5 pounds per acre. Segmented seed was planted at three different rates in each of the three years. A commonly-used type of sugar-beet

[1]Michigan Agricultural Experiment Station Quarterly Bulletin, 28 (2): Nov. 1945.
[2]Proceedings American Society Sugar Beet Technologists, 1946.

ARTICLE 31-57

drill was employed in planting in 1945. In 1946 and 1948 a Cobbley metering device attached to the same drill was used in planting the segmented seed.

RESULTS

Seed Germination and Pre-Blocking Stands

In 1945 the seedlings from natural seed emerged from the soil about 2 days earlier than did those from segmented seed. In 1946 and 1948 this difference was not detected. No differences in rate of emergence due to rate of fertilizer application were noted. However, after emergence from the soil had taken place, the seedlings on the more heavily fertilized plots grew more rapidly.

Stand counts were made prior to blocking on each 90-foot row of beet seedlings. This was done by laying a 50-inch rule at random against the base of the seedlings and counting the number of one-inch spacings on the rule that included one or more beet seedlings. The number was then multiplied by two. The resultant figure, herein called "germination stand" represents the number of beet-containing inches in 100 inches of row.

In the case of both segmented and natural seed, rate of fertilizer application had no effect upon germination stand.

Table 1 shows the effect of planting natural and segmented seed at varying rates upon germination stand (column 4). As would be expected, in any given year actual germination stand varied directly with the amount of seed planted. However, the data shown offer no positive means of predicting, in any year, the germination stand which will result from planting a given amount of segmented seed. A study of the figures given in Table 1 clearly reveals that conditions favoring germination and emergence were much more pronounced in 1946 than in 1945 and 1948. Interestingly, in no instance did the germination stand equal or exceed 30 percent when segmented seed was planted.

In order to determine the relationship between actual germination stand and potential germination stand, the latter figure was computed, and is shown in the fifth column of Table 1. Such a figure presupposes perfect distribution of the seed in the row and perfect germination and emergence. Obviously, actual germination stands were drastically lower than potential germination stands. In one case (1948, segmented seed at 3.3 pounds per acre), actual germination stand was only 16 percent of the potential germination stand.

Further examination of the field data sheets showed not only low actual germination stands but also uneven distribution of seedlings in the row. This indicates clearly the need for a planter which not only distributes seed uniformly in the row but which also places it in the soil in such a manner as to result in uniform germination and emergence.

TABLE 1—*A comparison of actual germination stand, potential germination stand and post-thining stand of sugar-beet seedlings grown from natural and from segmented seed*

Year	Type seed	Pounds of seed per acre	Actual germination stand	Potential germination stand	Post-thinning stand*
1945	Natural	11.5	45	100	100
1945	Segmented	6.3	27	100	88
1945	Segmented	3.7	16	91	77
1945	Segmented	2.6	15	64	74
1946	Natural	11.5	60	100	102
1946	Segmented	4.3	29	100	93
1946	Segmented	3.3	23	81	89
1946	Segmented	2.8	18	69	81
1948	Natural	11.5	34	100	103
1948	Segmented	7.4	27	100	101
1948	Segmented	5.9	25	100	101
1948	Segmented	3.3	13	81	78

*Number of beet seedlings per 100 feet of row 3 days after thinning.

Post-Thinning Stands

One hundred beets per 100 feet of row are considered a desirable post-thinning stand in Michigan. The right-hand column of Table 1 shows the post-thinning stands of beets in this experiment. In every treatment the amount of viable seed planted was sufficient to result in a uniformily spaced post-thinning stand of 100 or more beet seedlings per 100 feet of row. It will be noted that the use of natural seed planted at the rate shown resulted in an adequate post-thinning stand. This was not always true when segmented seed was planted.

In 1948, adequate post-thinning stands were obtained on plots in which the germination stand was 25 or more. In 1945 and 1946, germination stands of 27 and 29 resulted in post-thinning stands of only 88 and 93, respectively. This can best be explained by the fact that the same field workers were employed for blocking and thinning in 1945 and 1946. Another set of workers was employed in 1948. This emphasizes two things, namely: 1) germination stand cannot be regarded as a

figure whereby post-thinning stand, as accomplished by different workers, can accurately be predicted, and 2) the possibility of encouraging workers to space some beets at intervals closer than 1 foot in order to leave 100 beets per 100 feet of row.

Rate of fertilizer application had no effect on post-thinning stand.

Marketable Beets

Under Michigan conditions the number of marketable beets per 100 feet of row at harvest time seldom equals the post-thinning stand. Disease, mechanical injury and low soil productivity are common reasons for the failure of beet seedlings to reach marketable size. The relationships which existed between post-thinning stands and numbers of marketable beets are shown in the sixth column of Table 2. On the average, only 80 percent of the seedlings constituting the post-thinning stand attained marketable size in this experiment. In two seasons, 1945 and 1946, the percentage of beet seedlings attaining marketable size was greater in the segmented-seed plots than in the natural-seed plots. In 1948 this relationship was reversed. It appears that there is little basis for the belief that seedlings from segmented seed possess greater "livability" than those from natural seed.

Rate of fertilizer application had no effect upon percentage of beet seedlings reaching marketable size.

Sugar-Beet Yields

The right hand column of Table 2 shows the yields of sugar beets obtained from the various treatments. In 1945 beets grown from segmented seed outyielded those grown from natural seed. The yield difference was not great, although statistically significant at the 5 percent level. In 1946, 84 marketable beets grown from segmented seed outyielded 90 marketable beets grown from natural seed. In 1948 beets grown from natural seed outyielded those grown from segmented seed, although the differences were statistically non-significant because of great variation in plot yields. No conclusion can be drawn from the data concerning relationships between type of seed planted and acre yields. However, it is generally agreed that there exists in sugar beets a direct correlation between stand and acre-yield, provided the stand does not exceed 90 to 100 beets per 100 feet of row at harvest. If this is the case, the data herein presented strengthen the belief that, stand for stand, beets grown from segmented seed will yield as much, or

more than those grown from natural seed. In general, the figures also emphasize the importance of attaining high post-thinning stands when segmented seed is planted.

Table 2—*The effect of seed type and rate on post-thinning stand, number of marketable sugar beets and sugar beet yields*

Year	Type seed	Pounds of seed per acre	Post-thinning stand*	Marketable beets**	Marketable beets ÷ post-thinning stand	Yield—tons per acre
1945....	Natural........	11.5	100	65	.65	4.8
1945....	Segmented......	6.3	88	—	—	—
1945....	Segmented......	3.7	77	56	.70	5.2
1945....	Segmented......	2.6	74	—	—	—
1946....	Natural........	11.5	102	90	.88	13.1
1946....	Segmented......	4.3	93	84	.90	13.3
1946....	Segmented......	3.3	89	79	.89	12.8
1946....	Segmented......	2.8	81	76	.94	12.1
1948....	Natural........	11.5	103	88	.85	10.6
1948....	Segmented......	7.4	101	81	.80	9.8
1948....	Segmented......	5.9	101	79	.78	10.1
1948....	Segmented......	3.3	78	61	.78	9.4

*Beet seedlings per 100 feet of row 3 days after thinning.
**Beets weighing over 3 ounces per 100 feet of row at harvest time.

Labor Requirements in Thinning

The time required to block and thin sugarbeets grown from natural and segmented seed is shown in Table 3. On the average, 16 man-hours were required per acre on the natural-seed plots, whereas only 11.0 hours were required on the segmented-seed plots. This represents a labor saving of 31.3 percent. Herein lies the best reason for using segmented seed in preference to natural seed.

It is interesting to note that the labor saving was greater in 1946 than in 1945, even though the same workers were employed in both seasons and even though germination stands were higher in 1946 than in 1945. The only plausible explanation for this paradox appears to be the probability that those conditions which favor high germination and emergence, also make for uniformity of stand. If this is the case, then the pre-blocking stands of beets were more uniform in 1946 than in 1945 and, consequently, the workers required less time in "making decisions".

TABLE 3—*The amount of time required to block and thin sugar beets grown from segmented and natural seed*

Year	Type seed	Pounds of seed sown per acre	Time required to block and thin one acre	Labor saved
1945	Natural	11.5	17.5 hours	—
1945	Segmented	6.3	13.5 hours	22.9%
1945	Segmented	3.7	12.5 hours	28.6%
1945	Segmented	2.6	10.7 hours	38.6%
1946	Natural	11.5	15.2 hours	—
1946	Segmented	4.3	10.3 hours	32.9%
1946	Segmented	3.3	9.3 hours	36.9%
1946	Segmented	2.8	8.5 hours	43.7%
1948	Natural	11.5	15.3 hours	—
1948	Segmented	7.4	12.4 hours	18.9%
1948	Segmented	5.9	11.6 hours	24.2%
1948	Segmented	3.3	9.9 hours	35.3%

SUMMARY AND CONCLUSIONS

1. A field study of sugar beets grown from natural and from segmented seed was conducted during three different years. Comparisons were made between the two types of seed on the basis of seed germination, pre-blocking stand, post-thinning stand, number of marketable beets, acre-yield and labor requirements in thinning.

2. Type of seed used had no consistent effect upon earliness of emergence.

3. Rate of fertilizer application (200 pounds of 2-16-8 an acre and 500 pounds of 2-16-8 an acre) had no effect upon earliness of emergence.

4. Rate of fertilizer application had no effect upon germination stand.

5. In any given year germination stand varied directly with amount of seed planted. However, the data offer no positive means of predicting germination stand from amount of segmented seed planted.

6. In no instance did germination stand exceed 30 percent when segmented seed was planted.

7. Actual germination stands were drastically lower than potential germination stands for the amounts of seed planted.

8. Figures are presented which show that the relationship between germination stand and post-thinning stand is not constant—probably because of the varying quality of work done by different laborers.

9. Only 80 percent of the seedlings constituting the post-thinning stand attained marketable size (3 ounces or over) at harvest.

10. The data presented do not confirm the belief that seedlings from segmented seed possess greater "livability" than do those from natural seed.

11. Rate of fertilizer application had no effect upon percentage of beet seedlings reaching marketable size.

12. The data presented strengthen the belief that, stand for stand, beets grown from segmented seed yield as much, or more than, those grown from natural seed.

13. On the average, the use of segmented seed resulted in a labor saving of 31.3 percent in blocking and thinning, as compared with the use of natural seed.

AN APPRAISAL OF THE MARKET QUALITY OF MICHIGAN PEACHES
(PROGRESS REPORT)

By M. E. CRAVENS, JR. *and* H. A. CARDINELL[1]
SECTIONS OF AGRICULTURAL ECONOMICS AND HORTICULTURE

IN 1948, for the third consecutive season[2], receivers and consumers of Michigan peaches were given opportunity to express their opinions on the product which they purchased.

Twenty thousand bushels of peaches were included in the study. The fruit was packed in bushel boxes and ventilated baskets by three fruit exchanges in Berrien County in southwestern Michigan. They were treated prior to shipment by two methods, having the objective of reducing rot and waste, as follows: 1) Dusted with sulfur at the time of brushing, and 2) hydrocooled and treated with a liquid fungicide in a patented machine called an "FMC Stericooler".[3]

Receivers and consumers were asked specifically to comment on degree of ripeness and causes of waste, as outlined on a self-addressed post card included with each package. A reproduction of the card is on page 473.

Each card was numbered and an identifying record made of each shipment as to variety, date of shipment, type of treatment, and other essential shipping-point information. There was no identification to the customer of any of the treatments except for a printed label placed on some of the packages of "stericooled" fruit stating that they had been so treated. Of the 20,000 cards included with the shipments, 944

[1]The authors wish to express appreciation to the personnel of the Sodus Fruit Exchange, The Coloma Fruit Exchange and the Millburg Growers Exchange. These organizations made it possible to have cards placed in peach packs and to obtain information on the destination of a number of carlot and truck shipments. Michigan State College is especially indebted to the 944 dealers and housewives, who took the trouble to fill out and mail the postcards on which this study is based. Gratitude is also expressed to Dr. H. B. Tukey, Head, Department of Horticulture, for critically suggesting improvements in presenting this study.

[2]Cravens, M. E. Jr. and Arthur Mauch, Results of Experiments on Marketing Riper Peaches. Mich. Agri. Exp. Sta. Quart. Bul., 30 (4): 387-406. May 1948.

[3]Stericooling is a hydrocooling process using a chlorine type germicidal agent, "Hypo-clor", in a patented hydrocooler called the "F.M.C. Stericooler." In this process ice water containing the germicidal agent is run over the peaches for cooling and treating purposes. This is in contrast to the usual sulfur dust which is the standard treatment for peaches from packing houses in southwestern Michigan.

ARTICLE 31-58

RETAILERS AND HOUSEWIVES!!

During the past few years rot has cost peach dealers and consumers thousands of dollars annually. MICHIGAN STATE COLLEGE is experimenting with means of reducing these rots. This container is a part of the experiment. We want to know how these peaches "held up". Our only check of results under normal "trade" conditions is from the answers to this card. Please fill in the answers to the questions below.

Were these peaches:	Too ripe	☐
RIPENESS	Too green	☐
	About right	☐

Date of sale or use ....

Estimated WASTE in package from:

	Rot	.... lbs.
	Bruise	.... lbs.
	....	.... lbs.

This record is from:	retailer	☐
	housewife	☐

Comments: ....

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were returned. The replies received from retailers and housewives are given in the Tables.

REPORTS ON RIPENESS

Peaches were much more frequently classed as "too green" than "too ripe" (Table 1). This was especially true for Elberta peaches. With this variety seven times as many dusted and eighteen times as many stericooled peaches were classed "too green" as "too ripe". In the case of the Halehaven variety slightly more of the dusted peaches were reported as being "too green" than those that were stericooled. It was significant that about 60 percent of the buyers of Halehaven and 50 percent of the buyers of Elberta peaches classed them as being "about right", as far as ripeness was concerned.

Housewives less frequently classed peaches as "too ripe" and more frequently classed them as "too green" than did retailers. Since the reports are only from people who bought in bushel units for sale or for processing, these differences are significant. On the other hand, buyers almost never reported favorably on peaches rated as "too ripe". Only one-fourth of the comments on peaches being "too green" were favorable, while about two-thirds of those peaches rated as being "about right", were favorable. Apparently the housewives were think-

TABLE 1—*Peach ripeness rating for sulfur-dusted and stericooled peaches as reported by retailers and housewives*

Degree of ripeness	Packing-house treatment					
	Sulfur-dust			F. M. C. stericooler		
	Replies from			Replies from		
	Retailer	Housewife	All	Retailer	Housewife	All
	(Percent of replies)					
HALEHAVEN						
Too ripe	17	6	9	20	12	16
About right	63	61	61	60	63	60
Too green	18	24	23	12	19	16
Too green and about right	1	5	4	4	3	4
Too ripe and too green	1	3	2	—	3	2
Other	—	1	1	4	—	2
Total	100	100	100	100	100	100
Number of replies	88	229	317	25	32	57
ELBERTA						
Too ripe	10	1	6	4	1	2
About right	51	48	49	59	50	55
Too green	35	48	42	34	40	37
Too green and about right	1	—	1	1	6	4
Too ripe and too green	3	3	2	2	3	2
Other	—	—	—	—	—	—
Total	100	100	100	100	100	100
Number of replies	77	79	156	190	190	380

ing more of the immediate use for peaches, while the retailers were thinking of their ability to keep them until they were completely sold.

There was no apparent relationship between the method of treatment and the rating of ripeness. The dusted Elbertas were rated "too ripe" more frequently than were the stericooled ones, while for the Halehavens the reverse was true.

In several of the shipments which went through the stericooler the degree of ripeness at the time of packing and shipping was noted. The percentage of customers reporting that these peaches were "too ripe" was no different where the peaches were rated "green" when packed than where they were shipped in a "firm ripe" stage (Table 2). The percentage of buyers reporting them as being "too green", however, decreased from approximately 39 percent where "green" peaches were shipped, to about seventeen percent where "firm-ripe" peaches were shipped. The percentage reporting ripeness as being "about right" rose from 50 percent of the peaches shipped in the "green" stage to

TABLE 2—*Ripeness of stericooled Elberta peaches at time of shipping and replies from retailers and consumers concerning ripeness*

What retailers and consumers said	Degree of ripeness when packed*			
	Green	Green to firm	Firm ripe	All
	(*percent of replies*)			
Too ripe	2	4	2	3
About right	50	56	76	59
Too green	39	35	17	33
Mixed	9	5	5	5
Total	100	100	100	100
Number replies	56	128	46	230

*Average pressure as measured by 5/16 inch plunger: green, 25 pounds; green to firm, 18 pounds; firm ripe, 14 pounds.

about 76 percent of those shipped in the "firm ripe" stage. Apparently the peaches classed as "firm ripe" at the time of shipment gave much better satisfaction to the buyers than did either "green" or "green-to-firm" peaches. The fact that wholesale buyers realized this and paid a premium for "firm ripe" over "green" Elberta peaches on The Benton Harbor Wholesale Fruit Market was reported by Hathaway in 1947[4]

WASTE REPORTED BY PURCHASERS

No consistent difference was reported in the amount of waste between the dusted and the stericooled peaches. A very considerable

TABLE 3—*Amount and principal causes of waste in stericooled and sulfur-dusted peaches*

Method	Reported cause of waste*		
	Rot	Bruise	Total
	(*percent waste*)		
HALEHAVEN			
Dusted	7.4	5.4	12.8
Stericooled	10.4	5.4	15.8
Average	8.0	5.4	13.4
ELBERTA			
Dusted	11.8	6.2	18.0
Stericooled	10.4	4.0	14.4
Average	10.8	4.6	15.4

*Waste due to worms and other causes than rot was reported as being less than .05 of one percent.

[4]D. E. Hathaway, "Causes of Difference in Peach Prices on the Benton Harbor Market 1947, Preliminary Report". A. E. 2, August 1948, Agricultural Experiment Station, Michigan State College, East Lansing.

waste was reported for peaches with each treatment (Table 3). Stericooled Elberta peaches were reported with slightly less waste than were the dusted ones, while in the case of Halehaven peaches the stericooled ones were reported as having slightly more waste than the sulfur-dusted peaches. These results are in disagreement with those obtained in 1947 on a smaller number of cases. In the 1947 study the stericooled peaches showed less waste than did the sulfur-dusted ones.[5]

In addition to the data reported in Table 1, one dealer stated that he had made full refund on 122 out of 200 bushels of stericooled peaches he had sold. His description of them was that they turned black inside. These peaches had apparently frozen before he got them and he had bought them without knowing this. Since such an enormous loss was not a direct effect of stericooling and since it would throw the entire series of data out of balance, it was not included in the table. It is, however, one of the facts that must be taken into consideration in employing the stericooling treatment for peaches. This points out the need for instructing shippers and carriers as to the reduced needs for icing and salting in transit for precooled peaches.

Both housewives and retailers reported about the same amount of waste (Table 4). In the case of the Halehaven variety, retailers reported more waste than did housewives, while in the case of the Elberta variety the housewives reported more waste than did retailers. It was interesting to note that in the case of the Halehaven peaches comments from housewives were much more favorable than comments

TABLE 4—*Amount and cause of waste in percentage reported by different types of buyers*

Type of buyer	Reported cause of waste		
	Rot	Bruise	Total
	(*percent waste*)		
HALEHAVEN			
Retailer	9.8	5.2	15.0
Housewife	7.0	5.6	12.6
Average	8.0	5.4	13.4
ELBERTA			
Retailer	10.4	4.4	14.8
Housewife	11.4	4.8	16.2
Average	10.8	4.6	15.4

[5]See footnote 2.

TABLE 5—*Buyers rating of ripeness of peaches and percentage waste reported*

Reported ripeness	Reported cause of waste		
	Rot	Bruise	Total
		(percent waste)	
HALEHAVEN			
Too ripe	19.4	7.8	27.2
Mixed ripe and green	12.0	11.0	23.0
Too green	10.0	6.0	16.0
About right	4.6	4.4	9.0
Green and about right	4.4	3.0	7.4
Average	8.0	5.4	13.4
ELBERTA			
Too ripe	24.6	6.0	30.6
Mixed ripe and green	18.0	9.8	27.8
Too green	15.2	4.6	19.8
Green and about right	12.0	5.2	17.2
About right	5.6	4.2	9.8
Average	10.8	4.6	15.4

by retailers, while in the case of Elberta peaches the comments from housewives were less favorable than those from retailers. The cause, and particularly the amount, of waste and associated quality factors apparently had a considerable effect on the way these two types of buyers rated the peaches.

The comments on the stericooled peaches were somewhat more favorable than those on the dusted peaches. These more favorable replies and comments were due more to factors of quality than to freedom from rotting.

When the replies were grouped on the basis of the reported ripeness as stated by the buyer, wide variations were noted in the amount of waste. This waste was greatest in the case of peaches marked, "too ripe" by the buyer, and least in peaches marked, "about right" (Table 5). In the case of peaches rated as, "too ripe" the average waste was over one-fourth of the peaches in the basket while in the case of peaches rated, "about right", less than one-tenth was reported as the average waste. The greatest amount of bruising was found in peaches which customers marked as being "mixed ripe and green". In the case of peaches reported as being "mixed-ripe and green" the amount of bruising was almost double the average given for the four other groups. This mixing of peaches of different degrees of ripeness in the same container appears to greatly aggravate bruising.

Approximately one-third of the total waste reported by these buyers was blamed on bruising, and two-thirds on rotting. The number of

TABLE 6—*Range in the percentage waste caused by rots and bruises as reported by retail peach buyers*

Percentage waste	Halehaven		Elberta				Average
	Shipper No. 1		Shipper No. 1		Shipper No. 2	Shipper No. 3	
	Dusted	Stericooled	Dusted	Stericooled	Stericooled	Dusted	
				(percent of replies)			
				ROT			
Under 2 percent	38	35	44	42	41	31	39
2-6	30	22	15	18	31	20	24
7-12	12	7	13	13	11	9	12
13-19	6	3	8	4	4	4	5
20 and over	14	33	20	23	13	36	20
Total	100	100	100	100	100	100	100
				BRUISE			
Under 2 percent	43	54	58	59	45	31	49
2-6	30	19	25	24	32	26	27
7-12	12	10	6	11	13	20	12
13-19	4	2	3	2	5	3	3
20 and over	11	15	8	4	5	20	9
Total	100	100	100	100	100	100	100
				TOTAL WASTE			
Under 2 percent	20	19	29	27	19	13	22
2-6	28	24	17	19	30	17	24
7-12	15	13	15	17	21	13	16
13-19	10	3	7	8	10	11	9
20 and over	27	41	32	29	20	46	29
Total	100	100	100	100	100	100	100

pounds variation in waste reported as due to rots was much greater than that due to bruises.

The variation in waste reported by buyers of both Halehaven and Elberta peaches showed a wide variation. Almost two-fifths of the buyers reported less than one pound of waste per bushel due to rot (Table 6). On the other hand, one-fifth reported 20 percent or more waste due to rot. Such wide variation in waste due to rot suggests the need for more information concerning methods now used for controlling rot. If one-third of the peaches can be marketed with no more rot than one pound per bushel it should be possible for more to be as successfully grown and handled by the same methods.

Almost one-half of the growers shipped peaches in which the waste due to bruising was reported as being less than one pound per bushel,

or 2 percent. Those that showed more than 20 percent waste due to bruising represented about one-tenth of the total shipped. Here again the bulk of the shippers were satisfying their customers and it is possible that others could do likewise by following the same practices. Degree of fruit hardness and uniformity of firmness are important factors. Bruising can occur and reoccur anywhere between the picking of the fruit and the time when it is used.

Total waste varied from none to the loss of an entire bushel due to rotted and bruised fruit. Again, close to one-fifth of the lots shipped reached the customers with less than 2 percent waste, while another 25 to 30 percent had over one-fifth waste. A study of the reasons for these wide variations in waste should throw considerable light on the methods needed to control it.

DISTANCE PEACHES WERE SHIPPED

Over 80 percent of these peaches were sold within 650 miles of Benton Harbor, Michigan (Table 7). The stericooled peaches were shipped considerably farther than were the sulfur-dusted peaches. Stericooled peaches were practically all shipped under refrigeration, while a large part of the sulfur-dusted peaches were transported by truck and often without refrigeration. This difference in method of shipping might have more than offset the effect of normal deterioration due to the greater distance. A comparison of the waste due to rots and bruises, for peaches shipped varying distances, showed no consistent difference between them for each treatment. The lowest waste, both in Halehaven and Elberta peaches, was found in the shipments going more than 650 miles. There are, no doubt, many reasons for this. Brokers as well as owner-buyers usually demand the firmest

TABLE 7—*Distance from which post cards were returned*

Miles	Shipper No. 1				Shipper No. 2	Shipper No. 3	Total
	Halehaven		Elberta		Elberta	Elberta	
	Dusted	Stericooled	Dusted	Stericooled	Stericooled	Dusted	
	(percent of replies)						
Under 250 miles	47	14	24	10	4	61	27
251-650 miles	41	62	65	71	85	39	60
651-1050 miles	12	24	11	4	11	—	9
1051 and over	—	—	—	15	—	—	4
Total	100	100	100	100	100	100	100

peaches for their longest shipments. Packing-house supervisors often give out special instructions to "tighten-up" on all sorting and packing standards when a particular shipment is being packed. Shippers of "long-haul" fruit usually use the best insulated and refrigerated trucks or cars with built-in fans. Experienced brokers insist that precooling fans be used for an adequate length of time before cars are shipped. In recent years some buyers have specified that their loads be hydro-cooled, wherever a "Stericooler" was available. If one or more of these probable factors were not operating, one would expect that shipments traveling more than 650 miles would show the greatest waste. That such was not the case, indicates that better fruit and conditions must have been afforded than in the case of short-haul shipments. This is interesting and significant, because a similar study[6] was reported exactly one year ago. Peaches from the same packing-houses were reported as showing 20 percent waste, when shipped less than 400 miles and requiring an average of 3 to 4 days between shipping and consumption. On the other hand, peaches that were shipped "400 miles and over", requiring an average of 9.2 days, were reported as having only 16 percent waste.

Several studies have shown that adequate refrigeration effectively controls rots until the car reaches its destination. Voluntary replies of the type of postcard used in this study, where the ultimate sale or use is determined, makes possible the study of the effect of refrigeration, maturity of fruit and handling methods, on waste to the last step in the marketing process. It also allows for answers on factors other than waste. For refrigeration to be effective in the control of rots and other causes of waste, it must not permit an unfavorable quality. Such remarks as "rot before ripening", "cling to the pit", and other statements may be due partly to refrigeration before proper ripening. In this case, it is not refrigeration that is at fault but degree of ripeness and other harvesting and handling factors. In order to use refrigeration, stericooling and other methods of precooling and cold storing effectively, it will be necessary to re-examine maturity and handling procedures from the field to the packing house. Judging from the bitterness of the remarks from some of the customers, the sooner such an evaluation of harvesting and marketing methods is made the better it will be for the peach industry in Michigan.

[6]See footnote 1.

DISCUSSION

Other factors were more important in the control of peach rot than was refrigeration or stericooling. Tests made in 1948 indicated that at the present stage of development of refrigeration, stericooling or dusting with a fungicide for the control of rot cannot offset the bad effects of unsound production and handling practices. Such packing-house treatments offer a "last stand" before fruit goes to market. These treatments are not cure-alls for the control of rot. On the other hand, the stericooling process offers a means of taking the field heat out of the peaches in a very short time without any deleterious effect upon the fruit.

The large variations in waste reported suggest the possibility of determining the factors affecting waste by studying a large number of cases in which production, harvesting and packing practices are known. Since many growers and shippers are shipping peaches with a low amount of rot, a study of factors involved might be expected to reveal practices that would be effective for growers who now produce peaches that rot very badly.

The fact that between 50 and 60 percent of the replies indicated that peaches were "about right", as far as ripeness was concerned is quite encouraging. On the other hand, it indicates the need for continued attention to harvesting peaches at the proper stage of maturity. The bad showing of peaches of mixed ripeness indicates the need for more attention to picking and packing peaches of more uniform maturity.

The small amount of data where the ripeness in shipping was known, suggests the importance of packing a mature or firm ripe peach if consumers are to be satisfied.

WEED COMPETITION IN SMALL GRAINS IN THE UPPER PENINSULA

By A. R. WOLCOTT *and* R. F. CARLSON
SECTIONS OF FARM CROPS AND HORTICULTURE

THE IMPORTANCE OF controlling such conspicuous broad-leaved weeds as mustard and thistle in grain fields is fully appreciated by upper peninsula farmers. Even so, the extent to which grain yields are reduced by weed competition is generally underestimated. Particularly is this true when the competing species are grasses whose presence in the grain easily escapes attention.

Quack grass *(Agropyron repens L.)* is an aggressive perennial grass, the control of which is a major item in the cost of crop production in many areas in Michigan. In spite of the high cost of controlling it for row crops, a philosophy of "living with quack grass" is generally accepted in areas where it is established.

Quack grass makes a good quality hay when cut early, especially when topdressed with nitrogen in the spring. Good potato yields follow breaking up of a quack grass sod. In the Upper Peninsula summer fallow at frequent intervals following hay harvest is designed to give only temporary control. For spring grains the land is then plowed in the fall to expedite seed bed preparation in the spring. For potatoes the summer fallowed land is usually not plowed until the following spring. Good seedbed preparation and frequent early cultivation give control in the potatoes.

Under either of the above cropping programs, however, re-encroachment of quack grass begins in the first grain crop and continues through the rotation. Most hay meadows in their first year contain from 20 to 50 percent quack grass, regardless of the forage species seeded.

Casual observation of the rapidity with which a stubble-field greens up with quack grass as soon as the grain is removed—where only a few spears of grass were observed in the grain—will suggest that consider-

ARTICLE 31-59

able unseen growth of rhizomes has taken place. Little consideration is given to the extent to which this subsurface development competes for moisture and nutrients with the grain crop.

That this competition may be considerable is indicated by data gathered at the Upper Peninsula Sub-station at Chatham for purposes of estimating the extent to which weed competition reduces small grain yields.

PROCEDURE

Four areas were selected in a field of oats where it was possible to take paired samples out of a patch infested with quack grass and out of the adjoining quack-grass-free area. Four samples (1/5 rod square) were cut out of the grass-infested patches, taking all surface growth. Four corresponding samples were taken out of the adjoining grass-free areas.

The quack grass was separated from the grain and the green material weighed. The samples of grass and grain were dried and weighed again, after which the grain was threshed, and the threshed grain weighed.

Four pairs of samples were similarly treated from four areas in a field of mixed oats and barley where patches of Canada thistle (*Cirsium arvense* L.) were surrounded by areas of clean grain.

TABLE 1—*Effect of quack grass and Canada thistle growing in grain on total yields of surface plant material and surface dry matter and on the yield of threshed grain*

Crop	Green plant material			Dry matter			Threshed grain	
	Total weight grams per plot	Gain over check	Weeds	Total grams per plot	Gain over check	Weeds	Yield per acre	Reduction in yield of check
	grams	*percent*	*percent*	*grams*	*percent*	*percent*	*bushels*	*percent*
Oats	1,310	....	....	719	....	....	89	....
Oats plus quack grass	1,104	13 less	28 (quack grass)	617	12 less	23 (quack grass)	62	30
Oats and barley	880	....	....	534	....	....	65	....
Oats and barley plus Canada thistle	1,275	46 more	53 (thistle)	538 more	1.0 more	34 (thistle)	45	30

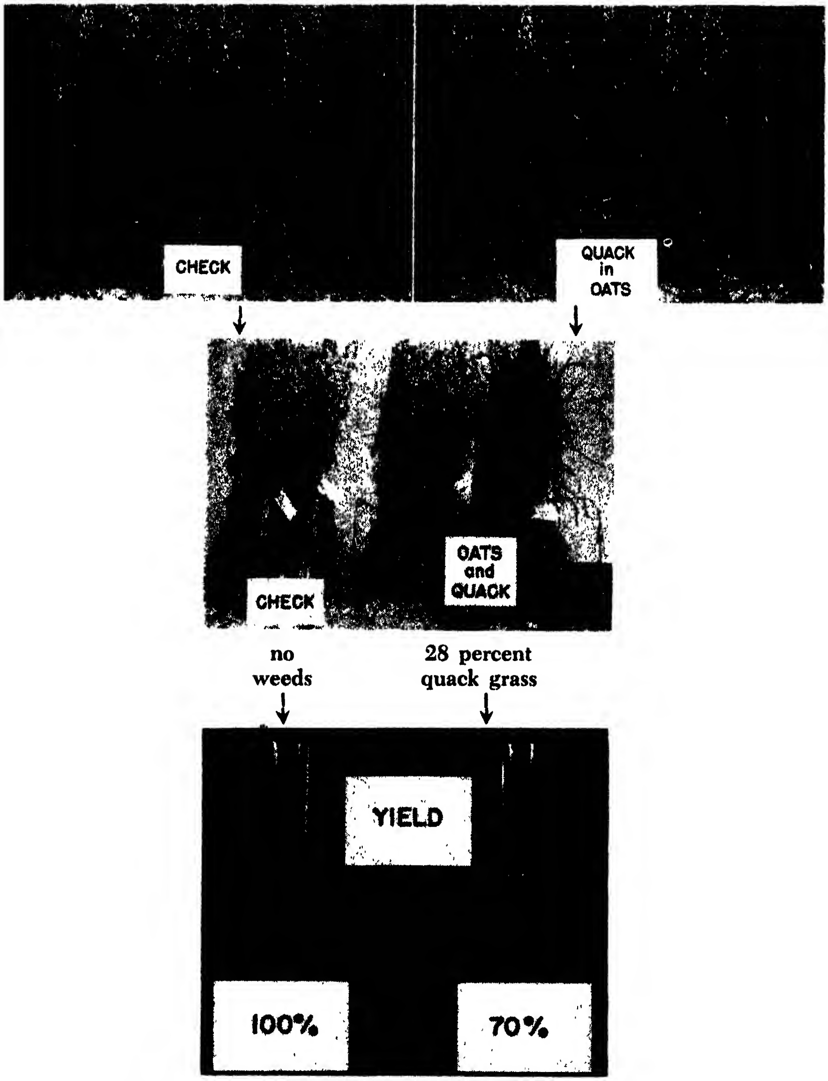

Fig. 1. Top two photographs compare appearance in the field of a stand of grain without weeds (left) with a stand containing 28 percent quack grass (green weight basis) on the right.

Center photo shows the harvested green plant material after quack grass had been separated from the oats. Total weight of oats and quack (right) was 13 percent less than weight of oats alone grown on an equal area without weed competition (left).

Bottom photo shows proportionate yields of threshed grain from the two areas.

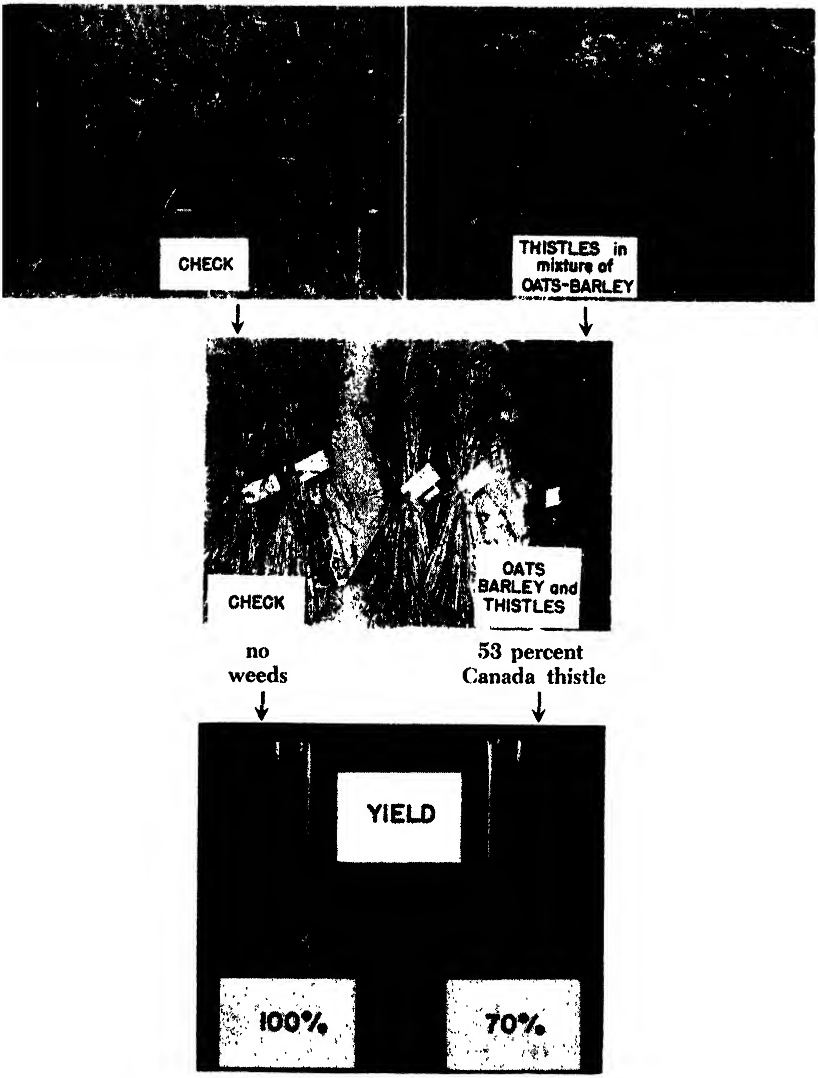

Fig. 2. Top two photos compare appearance in the field of a stand of grain without weeds (left) with a stand containing 53 percent Canada thistle (green weight basis) on the right.

Center photo shows the harvested green plant material after the thistles had been separated from the grain. Total weight of grain and thistles (right) was 46 percent greater than weight of grain alone grown on an equal area without weed competition (left).

Bottom photo shows proportionate yields of threshed grain from the two areas.

The data summarized in Table 1 are based on the averages of four samples for each determination.

Figures 1 and 2 show the effect of quack grass and Canada thistle on grain yields.

RESULTS

1. Quack grass growing in competition with grain reduced the total weight of green plant material produced above ground by 13 percent, while thistles increased green surface growth by 46 percent.

2. The dry matter produced as surface growth on these same plots was reduced 12 percent by quack grass, and increased slightly by thistles.

3. An apparent 28-percent infestation of quack grass (based on green plant material) reduced grain yields as much as a 53-percent infestation of Canada thistle. The reduction of grain yields in both cases was 30 percent.

4. In the case of quack grass, the percentage reduction in yield was greater than the percentage of surface dry matter produced as quack grass. With thistles this relationship was reversed.

DISCUSSION AND CONCLUSIONS

Casual observation supported by the foregoing data indicates that when quack grass grows in grain the total tonnage of surface growth is reduced—a situation not observed nor indicated by the data for Canada thistles growing in grain. This may be due partly to the fact that the much deeper root system of thistles draws for nutrients and moisture from a larger soil volume than either grain or quack grass. However, observations in the field support the further conclusion that when surface growth of quack grass in cultivated fields is partially suppressed by crowding and shading by competing species, a small amount of surface growth will support a large amount of rhizome development.

This unseen subsurface growth has generally been ignored in discounting the effect of relatively light infestations of quack grass—as judged by observation of surface growth—in reducing grain yields.

The data indicate that the effect of quack grass in reducing yields is often underestimated.

Grains, being grasses themselves, afford concealment for significant infestations of quack grass, as is shown in the series of pictures in

Fig. 1. Thistles, with their spectacular flowering and fruiting habits are very conspicuous in a grain field (Fig. 2). The average farmer ignores the grass, which may infest his whole grain acreage, while he goes to great pains to stamp out the thistles which usually occur only in scattered patches.

Yet, the data presented indicate that, on a given soil, on either a green weight or a dry matter basis, production of a given weight of surface plant material as quack grass may reduce grain yields more than production of an equivalent weight of surface plant material as thistles.

The quack grass infestation on the plots harvested in this study was not extreme. The "quack" areas were detected only by walking through the grain.

JOURNAL ARTICLE ABSTRACTS

Investigations on the Fluorometric Determination of Malic and Succinic Acids in Apple Tissue

BARR, C. G.

Plant Physiology. 23 (4): 443-454. 1948. [Journal Article 757 (n. s.) from the Michigan Agricultural Experiment Station]

A photometric method has been developed for the quantitative determination of malic and succinic acids in mixed solutions and in certain plant tissues, outlined as follows:

When heated with resorcinol and sulfuric acid they yield compounds which show intense fluorescence under certain conditions. Fluorometric separation of the succinic-acid and malic-acid derivatives is accomplished by controlling the exciting light and reaction of the test solution. Dilute solutions of the succinic acid derivatives show an intense green fluorescence in acid reaction when illuminated by light of wave length 420 to 520 millimicrons. The malic acid derivative shows virtually no fluorescence under these conditions but fluoresces a brilliant blue in basic solution under ultraviolet light of 320 to 420 millimicrons in length.

Influence of Oil-wax Emulsions Sprays on Size of Montmorency Cherries

NEAL, A. L., GARDNER, V. R., BARR, C. G., RASMUSSEN, E. J. AND MILLER, E. J.

Journal of Agr. Res. 77 (9 and 10): 261-270. 1948. [Journal Article 857 (n. s.) from the Michigan Agricultural Experiment Station]

Five different oil-wax emulsions containing various proportions of paraffin wax, linseed oil, soybean oil and Bentonite, together with certain emulsifying agents, were applied as sprays to small potted cherry trees in the greenhouse and to bearing cherry and apple trees in the orchard. The greenhouse applications resulted in significant reductions in transpiration rate. The orchard applications resulted in significant increases in size of the fruit in the case of the cherries. Presumably these were associated with decreases in transpiration rate. The results obtained with apples in the orchard were variable.

The Effect of Certain Chemical Agents on the Virus of Newcastle Disease of Chickens

CUNNINGHAM, C. H.

Jour. Vet. Res. 9 (31): 195-197. 1948. [Journal Article 892 (n. s.) from the Michigan Agricultural Experiment Station]

A number of chemical agents were tested for their effect on an egg-propagated strain of the virus of Newcastle disease of chickens during an exposure period of three minutes. Following the exposure period, the virus-chemical mixture was injected into the allantoic cavity of embryonated chicken eggs. Some of the mixtures were injected into the eggs directly while others were diluted with sterile distilled water to a chemical concentration which previous experiments had shown to be nontoxic for embryos. Survival of the inoculated embryos for six days was considered as evidence that the material injected did not contain active virus.

The following preparations were effective against the virus in three minutes or less: ethyl alcohol, 95 and 70 percent; tincture of iodine, 2.5 and 1.0 percent; phenol 3 percent, liquor cresolis saponatus, 3 and 1 percent; lysol, 3 and 1 percent; creoline Pearson, 3 and 1 percent; potassium permanganate, 1:1,000; lysol, 3 and 1 percent; mercuric chloride, 1:1,000; sodium hydroxide, 5 and 2 percent; clorox, 20 and 5 percent; Disilyn, 1:512; Roccal, 1:1,000; tincture of metaphen, 1:200; tincture of zephiran, 1:1,000; phemerol, 3 and 1 percent; and formalin, 10 percent.

The following preparations were without effect on the virus during the three-minute exposure period: ethyl alcohol, 40 and 25 percent; tincture of iodine, 0.1 and 0.01 percent; phenol, 1 percent; potassium permanganate, 1:10,000; mercuric chloride, 1:10,000; sodium hydroxide, 1:10,000; clorox, 1 percent; quarternary ammonium compound number 2, 1:10,000; tincture of metaphen, 1:20,000; tincture of zephiran, 1:100,000; merthiolate, 1:1,000 and 1:10,000; formalin, 1.0 and 0.01 percent; and boric acid, 4 percent.

Green Tissue Testing with the Spurway Soil Testing Equipment as an Aid in Soil Fertility Studies

COOK, R. L., ROBERTSON, L. S., LAWTON, KIRK, AND ROOD, P. J.

Soil Sci. Soc. of Am. Proc. 12: 379-381. 1947. [Journal Article 914 (n. s.) from the Michigan Agricultural Experiment Station]

The testing of green plant tissue is recognized as a valuable aid in soil fertility investigations. The Spurway soil testing equipment described in Michigan Agricultural Experiment Station Technical Bulletin 132 (3rd. revision) 1944, has been used successfully for testing green plants. Directions are given for making such tests. It is advisable to keep green tissue tests on a comparative basis, always comparing test results from unknown plants with those from plants known to be normal.

Tests were conducted to prove the validity of results obtained by analyzing green tissue with the Spurway equipment. In the greenhouse it was possible to predict from tissue tests which plants had received sufficient ammonium nitrate for maximum yields and which were starved for nitrogen.

In field experiments with alfalfa and clover it was possible in most cases, by either the phosphorus or potassium test, to distinguish between treated and untreated plots and between plots treated only with phosphorus or only with potash. Thus the method was shown to be very sensitive and reliable as an indication of the supply of nutrients in the soil for a certain plant at that particular time.

A Study of Correlation Between Rapid Soil Tests and Response of Legume Hay to Phosphorus and Potassium Fertilization on Some Michigan Soils

LAWTON, K., ROBERTSON, L. S., COOK, R. L., AND ROOD, P. J.

Soil Sc. Soc. Am. Proc. 12: 353-358. 1947. [Journal Article 915 (n. s.) from the Michigan Agricultural Experiment Station]

Fertilizer plots designed to study correlation between crop yield and rapid soil tests were laid out at 66 locations on established alfalfa stands in lower Michigan in 1946. Soil samples were taken before treatments were applied and at the harvest time of first cutting over a two-year period. Four rapid soil testing methods were compared.

Application of 150 pounds per acre of P_2O_5 and K_2O alone and in combination resulted in an average increase in yield of 34 and 52 percent, respectively, for phosphate and phosphate-potash treatments in 1946. Little benefit was found

from potash applied alone. Over 90 percent of the experiments showed a significant increase in yield of the phosphate-potash treatment over the check. The results of 55 experiments continued in 1947 were similar to those of the previous year, though crop response to all treatments was lower.

Linear correlation between hay yields and four different rapid soil testing systems was found to be of limited value in predicting yield response from soil tests. The prediction of significant yield response of hay from fertilizer using narrow and critical nutrient levels was found to be from 70-80 percent accurate in the case of phosphorus. For potassium this accuracy was from 55-65 percent. Discrepancies are attributed to varying seasonal weather conditions, wide variation in soils studied as regards texture, organic matter content, and pH, and differences in the composition of the hay crop.

A separation of the soil studied into three textural-drainage groups facilitated the establishment of more accurate soil test-crop response levels. No specific soil testing system was noted to be substantially superior to the others under observation, if adequate soil and plant data relative to crop response to fertilizer was available.

Tests in 1947 Against the Two-Spotted Spider Mite

SHERMAN III, FRANKLIN, AND KING, H. L.

Jour. Economic Entomology. 41 (5): 807-808. 1948. [Journal Article 922 (n. s.) from the Michigan Agricultural Experiment Station]

In six series of single-spray tests conducted in Michigan apple orchards, parathion gave outstanding control of the two-spotted spider mite, *Tetranychus Bimaculatus* Harvey. Used as a summer spray at the rate of 2.5 pounds of 25 percent wettable powder, this material killed practically all of the mites present at the time of application and left a residue which killed mites hatching after the treatment. The dicyclohexylamine salt of dinitro-o-cyclohexyl phenol, tetraethyl pyrophosphate and hexaethyl tetraphosphate were somewhat less effective than parathion and did not exhibit any residual effect. Bis(p-chlorophenoxy) methane was ineffective.

The Control of Red-banded Leaf Roller with Parathion

KING, H. L., HUTSON, RAY, AND FARR, T. H.

Jour. Economic Entomology. 41 (6): 976-977. 1948. [Journal Article 929 (n. s.) from the Michigan Agricultural Experiment Station]

In replicated orchard treatments 4 cover sprays of O,O-diethyl, O-p-nitrophenyl thiophosphate (parathion) used at the rate of 0.6 pound per 100 gallons of water gave excellent control of red-banded leaf roller on Cortland, Snow and Jonathan apples, but not significantly better than 3 pounds of lead arsenate or 0.25 pound of parathion. The amount of 0.75 pound of DDT gave inferior control. Wettable powder formulations containing 15 and 25-percent parathion gave similar results when used at equivalent concentrations. Spray applications caused no significant change in yield, and no spray injury was observed. Chemical analyses indicated negligible residues of parathion 3 weeks after spraying.

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